SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

FRIDAY, JANUARY 3, 1908

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

LORD KELVIN

WITH the death of Lord Kelvin on December 17 there passes away the grandest figure of contemporary science, and with it closes an epoch in the history of physics. When William Thomson was born, in 1824, Ohm's law of the flow of electric currents had not been discovered, Oersted's discovery of the magnetic action of the current was but four years old, while Faraday's capital discovery of the induction of currents was not to come for seven years. The wave-theory of light had been but recently set on its feet by Young and Fresnel, and was not yet thoroughly believed, while the two laws of thermodynamics, perhaps the most important contribution of the nineteenth century, were unknown. All these things Lord Kelvin saw, and a great part of them he was. Probably no one, with the single exception of Helmholtz, born three years earlier, exercised a greater influence on the science of the nineteenth century, while to compare the influence of these two great physicists with that of Darwin is as bootless as to question whether the grass is greener than the sky is blue.

Whether William Thomson, born at Belfast, is to be classified as an Irishman, along with the great Sir William Rowan Hamilton, or by virtue of descent and almost lifelong residence in Glasgow, as a Scotchman, like that other genius Clerk Maxwell, we need not discuss, but that country in which, perhaps in all the world, intellect is most prized, may fairly claim

him as her own. The fact that his father was professor of mathematics at the University of Glasgow, where his elder brother James became a distinguished professor of engineering, tends to show the hereditary nature of his talent. Brought up in the quadrangle of the university, Thomson as a boy must have enjoyed very unusual advantages of training, while he relates that the enthusiasm of J. P. Nichol, author of "The Architecture of the Heavens," first turned him in the direction of physics, while the good advice of the same master, encouraging him to read Fourier's "Théorie analytique de la Chaleur" bore quick fruit, which was renewed throughout his whole career. Precocious he certainly was, for his first paper, written at the age of seventeen, was on Fourier's expansion of functions in trigonometric series, followed by three others on the flow of heat, all written before he was eighteen. It is impossible to conceive of an American boy of seventeen to-day writing on such a subject, which still presents many difficulties even for the mature student, and at that time was understood only by the masters. The theory that precocity is a dangerous symptom receives a severe blow from Thomson's subsequent career.

After being educated at Glasgow University he went to Cambridge, and joined St. Peter's College, where he distinguished himself by becoming second wrangler in the Mathematical Tripos, and first Smiths Prizeman, a mathematical honor still more coveted, in 1845. On leaving Cambridge Thomson went to Paris, where in the laboratory of the distinguished physicist, Regnault, he had his first introduction to experimental methods of research. At this time he published the second of his papers on the laws of electrostatics, showing the analogy, never before noticed, between the distribution of what Faraday was calling electrical lines of force with the lines of flow of heat in a conductor. In this, as in most of his work then and later, we see the great influence that the work of Fourier had upon him, and the powers which he had obtained in the management of that analysis. In the same year he published his original method of spherical images, which has become of so great importance in all parts of mathematical physics.

In 1846, at the age of twenty-two, Thomson became professor of natural philosophy at Glasgow, where he remained fifty-three years, his jubilee being celebrated with great *éclat* in the presence of illustrious scientists from all over the world in 1896. Besides his powerful contributions to the theory of electricity and magnetism, which continued for many years, a new and no less important subject now began to engross him. The work of Sadi Carnot on the motive power of heat, though published in 1826, was but little understood, and belonged to the days when heat was supposed to be a substance. Almost simultaneously, Thomson in England, and Clausius in Germany brought out explanations of Carnot's principle that heat can do work only in falling in temperature, that is in passing from a hotter to a cooler body, each inventing a new axiom to take the place of Carnot's faulty analogy with the fall of water. The statement of this axiom by Clausius is easier to understand, and it led him to the important conception of entropy, but the line of argument of Thomson was no less original and compelling, and it led him to the idea of dissipation of energy, which amounts to the same thing. It is worthy of notice that when Thomson began to write on the subject of thermodynamics he still believed heat to be a substance, but he soon accepted the results of the reasoning of Helmholtz and the experiments of Joule on the nature of heat as work, or as we now call it, energy. The most important outcome of Thomson's thermodynamical

work was the invention of the absolute scale of measurement of temperature, which is independent of the properties of any thermometric substance such as mercury or air. By a fortunate accident this scale (or one of the two proposed), coincides nearly with that of a thermometer using one of the more permanent gases like hydrogen or nitrogen. The question of how nearly it coincides could be decided only by experiment, and these experiments were carried out from 1852 to 1862 by Thomson and Joule in collaboration, the most important result obtained being that on being forced through a porous plug all gases except hydrogen were slightly cooled, this cooling being shown to be due to the slight attraction of the molecules of the gas for each other, in spite of the tendency of the gas to expand on account of the motion of the molecules. It is probably by these researches that Thomson as an experimental physicist will be chiefly remembered, for they furnish us, by the Joule-Thomson effect, with our only means of reducing the indications of an actual gas thermometer to the absolute scale.

We now come to a new subject, and the one which made Thomson famous in the eyes of the public, and which eventually procured him his knighthood. At the beginning of the agitation of the project of the Atlantic telegraph cable, Thomson plunging with enthusiasm directly into the heart of the matter, took up the mathematical question of the mode of propagation of signals in a telegraph line laid under water. To this he again applied his favorite Fourier mathematics, and in 1855 he communicated to the Royal Society a paper in which the theory was completely worked out, in which it was shown that the current is propagated exactly as heat is conducted, and that instead of being propagated with a definite velocity, like sound, so that a short signal would arrive, pass over and cease, the current would arrive gradually, increase to a maximum, and die away, always leaving an undesirable residue to trouble the next signal. The longer the cable the longer would it take for the current to rise to its maximum, but not in proportion. The vital question was, how long would it take, and how much current could be got through, and this he solved in the most convincing fashion, with the announcement of the possibility of the prediction of the action of one cable by the behavior of another. If K is the capacity per unit of length, R the corresponding resistance, the time at which a signal reaches its maximum value at a distance d away is proportional to the product KRd^2. This is the famous KR-law, and then follows the remarkable prediction, "We may be sure beforehand that the American telegraph will succeed, with a battery sufficient to give a sensible current at the remote end, when kept long enough in action, but the time required for each deflection will be sixteen times as long as would be with a wire a quarter of the length, such, for instance, as the French submarine telegraph to Sardinia and Africa." The mastery of the principles of the telegraph thus shown led to the appointment of Professor Thomson as electrician of the first cable laid in 1858, a position which he held many times for later cables. Not content with showing the conditions necessary for success of working, Thomson had invented an instrument to make possible the reception of the weak signals to be transmitted, and his mirror galvanometer was ready when the shore end of the cable was laid. The important principle of this galvanometer was not merely the long weightless index consisting of a beam of light, the mirror principle having been invented by Poggendorf, but the reduction of the moving magnet to a very small light affair weighing less than

a small sewing needle, and giving wonderful sensibility. Thomson was the first to insist on the advantage of small size in magnetic and other measuring instruments, and his galvanometer became the model of all delicate galvanometers from that time to this, each increase in lightness having been attended with an increase of sensitiveness. It is interesting to recall, in connection with the first cable, which lived to transmit only 732 messages, that it was ruined by the practical, that is non-theoretical, electrician, Mr. Whitehouse, who applied to it currents from huge induction coils, probably giving potentials of two thousand volts. By the advice of Thomson, thus dearly paid for, this was reduced, on the 1865 cable, to a few volts, this being amply sufficient to work his delicate instruments. The mirror galvanometer, together with the electrometers invented before the cable was talked of, were the first of Thomson's many electrical measuring instruments, by which he will perhaps best be remembered by practical people. Later he invented the siphon recorder, still in use for *recording* cable signals. Thus Thomson became the first, as he was the greatest, of electrical engineers, telegraph engineers then, but now embracing the many fields of telegraph and telephone, wireless, and transmission of power. In this connection may be mentioned his connection with the establishment of practical units for all electrical measurements, first made imperatively necessary by the cable, and lying at the basis not only of all exact measurement, but of all practical engineering. A committee of the British Association for the Advancement of Science was appointed, with Thomson as chairman, to consider the question of units in general, and in 1863 they made the determination of a practical unit of resistance, now known as the *ohm*, the method of experimentation being devised by Thomson. Finally the efforts of this committee culminated in the proposition of what is known as the C.G.S. system of absolute measurements for every sort of physical quantity, this system being now in use by every scientist and electrical engineer in all parts of the globe.

We may now say a few words of Thomson's instruments. Of the galvanometer we have already spoken, this being the most easily understood of his instruments, and used for measuring current. For the measurement of potential he devised two electrometers, acting on the principle of the attraction and repulsion of statically electrified bodies. In one, the absolute electrometer, a horizontal plate was hung from the arm of a balance, which weighed the attraction due to a parallel fixed plate. This idea was again not invented by Thomson, but by Snow Harris, who, however, did not understand how to get correct results with it. The bright idea conceived by Thomson was to surround the disk with a so-called guard-ring, the idea being that as the calculation supposed an infinite plate, the suspended disk should be, as it were, a sample of a larger plane surrounding it, the disk alone being movable. Thus the demands of theory and practise were both met at once, and exact calculation became possible. In the quadrant electrometer a quite different, but equally original arrangement was adopted. The moving part was made in the shape of a horizontal figure of eight, and turned about a vertical axis, most delicately supported by a silk fiber, and attracted and repelled by a circular box enclosing it, cut into quarters, which alternately attracted and repelled, but so as to combine their action, giving a most delicate instrument. These instruments, like the galvanometer, have become classical. By his journeys on cable ships, and his practical experience as a yachtsman, Thomson devoted much thought to the needs of navigation, and

invented a sounding apparatus using steel piano wire instead of rope, with a depth indicator depending on the pressure of the water, and a compass, both of which are to-day in universal use. The principle of the compass was again that of lightness for sensitiveness, the card being supported by silk strings. He also elaborated the method of correction of the compass for the ship's magnetism. Later on came instruments for the measurement of the large currents and potentials used in present-day practise.

The culmination of Thomson's application of Fourier mathematics, and perhaps his most sensational contribution to science, was his estimate of the age of the earth, based upon the time it has taken to cool, our knowledge being derived from the measurement of the rate of increase of temperature as we go below the surface of the earth. His conclusion was that the earth had required from one to two hundred million years to cool from its molten state to the present, a conclusion which was a violent shock to the geologists, who required a far greater period for the formation of the rocks.

None of the above-mentioned subjects was, however, Thomson's favorite subject of research, the place of which must undoubtedly be given to his speculations on the nature of the ether, and the constitution of matter. In fact, he stated at his jubilee that there had not been a day during the last forty years when he had not devoted some time to the consideration of these subjects, but that the total result must be summed up as failure, inasmuch as he knew no more of their true nature now than at the beginning. This discouraging admission must be taken with several pailfuls of salt, and attributed to that true scientific humility which is the characteristic of great minds, for there is no one who has contributed more to our knowledge of both ether and matter than Thomson. His fondness for this subject was a symptom of his devotion to and mastery of the principles of mechanics, whether in its applications to rigid bodies, to elasticity, or to hydrodynamics. In connection with his contributions to geology may be mentioned his powerful researches on the tides, of both fluid and solid spheroids, and his conclusion from the motion of the earth that it is nearly as rigid as a sphere of steel. Thomson and Tait's "Treatise on Natural Philosophy" (roguishly referred to by Clifford as $T + T'$) was an epoch-making work, conceived on a scale never before attempted, and destined to be completed only in the first instalment devoted to mechanics, on which subject it constituted a wonderfully inspiring guide. This work, which Helmholtz thought enough of to translate into German, is difficult of characterization, but we may mention its insistence on the value of Newton's ideas, and its exposition of the power of Lagrange's generalized methods in dynamics. The portion which perhaps best shows the originality of Thomson's genius is the chapter on systems containing rotating gyrostats, of whose peculiar action it gives the complete key. The recent application of these principles in the Brennan mono-rail railway and the Schlick gyrostat for preventing the rolling of ships is no more interesting than Thomson's use of them to construct from rigid materials a model of an elastic atom, in his "Steps toward a Kinetic Theory of Matter," read at the British Association meeting in Montreal in 1884, or his model of a gyrostatic ether whose elasticity was to be similarly explained.

This occasion of Thomson's first visit to the United States was otherwise signalized by the deliverance at the Johns Hopkins University of a remarkable

series of lectures on "Molecular Dynamics and the Wave Theory of Light," before a very unusual auditory from both sides of the ocean. These lectures, first published twenty years later, were characteristically Thomsonian, and represented his long attempt to make the elastic theory of the ether work successfully. Constructing a model of a molecule by means of concentric hollow shells with springs between to give many modes of vibration, he was led to an explanation of anomalous dispersion, without knowing of its experimental discovery by Kundt and Christiansen, or its explanation by Helmholtz ten years before. This ignoring of the work of others was characteristic of both Thomson and Helmholtz, and perhaps constitutes the strength of great thinkers. Possibly in this way is to be explained Thomson's cold attitude toward the electromagnetic theory of light, which he maintained until after the world in general was convinced of its truth. He was determined at all hazards to make the elastic ether do, probably because he saw that even if light is to be explained as electromagnetic waves, we have still to give a dynamical explanation of electricity and magnetism. Of late years the pendulum has swung the other way, and there is now an attempt to explain all dynamics on an electromagnetic basis, but with this Lord Kelvin would probably have had no sympathy. In these Baltimore lectures we find a remarkable description of a probable way to make electric waves, which was almost exactly realized by the method of Hertz three years later, coupled with the erroneous opinion, from which Thomson could hardly rid himself, that they would be waves of compression, and would travel much faster than light. In order to explain elasticity, he had a penchant for the ideas of Father Boscovich, of forces emanating from centers, from which he built up atoms, ether, and even made application to radioactivity. One of his last papers is on a "Plan of an Atom to be capable of storing an Electrion with Enormous Energy for Radioactivity," and in a paper with the characteristic title of "Æpinus Atomized" he put forth the model of an atom consisting of a globe of positive electricity permeated by a multitude of minute negative *electrions*, as he persisted in calling them, ignoring the general use of the word electron.

Lord Kelvin devoted a considerable portion of his energies to tilting at windmills and championing lost causes. Of this his treatment of the elastic and electric theories is an example. Another *bête noire* in late years was the Maxwell-Boltzmann theorem of the partition of energy, which he characterized as a cloud upon the kinetic theory of gases. The writer once enjoyed the good fortune of spending several days in the company of Lord Kelvin, and of hearing him frequently training his guns on that target. At last he plucked up courage to ask, "Lord Kelvin, what do you consider to be the fundamental error in the argument of Maxwell and Boltzmann?" "I don't think there is a single thing about it that is right," was the instant comprehensive answer, to which there appeared no obvious reply.

Lord Kelvin's personality was a most attractive and original one. To see him and hear him talk was to be lost in admiration of his vigor, his quickness and his enthusiasm. Nothing was lost to him, and he was never idle. In the railway carriage on the return to London on the occasion mentioned he soon pulled out his note-book, and was figuring on the ether flowing through an atom, the result of which figuring was apparent the week after at the Paris congress. Helmholtz, on a visit to Thomson on his yacht, the *Lalla Rookh*, writes to his wife, after admiring the skill with which Thomson managed the yacht,

"It was very pleasant and informal. W. Thomson has carried the freedom of intercourse so far that he always carries a mathematical note-book about with him, and as soon as an idea occurs to him, begins to reckon right in the midst of the company, which is generally regarded with a certain awe. How would it be if I should accustom the Berliners to that?" On the occasion of a visit in Glasgow he writes, "He has no vacation at Easter, but his brother James, professor of engineering at Belfast, and a nephew, are there. The former is a very clever head with good ideas, but hears and knows nothing but engineering, and speaks of it continuously at all times of the day and night, so that hardly any conversation can take place when he is there. It is funny, too, how each of the brothers explains something to the other, and neither listens to the other, and each talks of totally different subjects. But the engineer is the most obstinate of the two and generally puts his piece through." The friendship between these two great physicists, Helmholtz and Thomson, both without other peers, was most interesting from the fact that they many times almost simultaneously treated the same subjects, and that they were both examples of Helmholtz's statement that "in physical science he only can fruitfully experiment who has a penetrating knowledge of theory and according thereto can ask the right questions, and on the other hand, as is most brilliantly shown in the discovery of spectrum analysis, he only can fruitfully theorize who has a broad practical experience in experimentation." Would that these words and these examples might be carved in letters of gold in every laboratory in this land!

The honors heaped upon Thomson would fill a catalogue. Knighted in 1866, he is most familiarly known as Sir William Thomson, elected foreign associate of the Paris Academy of Sciences in 1877, he was raised to the peerage by Lord Salisbury in 1892, taking the title of Baron Kelvin, from the stream on which Glasgow is situated. He was president of the Royal Society, four times president of the Royal Society of Edinburgh, and member of nearly all the learned societies of the world. He was one of the twenty members of the recently instituted Order of Merit, of which the other scientific members are Lord Rayleigh, Sir William Huggins and Lord Lister. On his third visit to this country, in 1902, he was tendered by several scientific societies a great reception at Columbia University, where his praises were sung before a distinguished company. His visit to the American Physical Society was a memorable one for that society, of which he was the first honorary member. Kelvin's printed works comprise one volume of "Papers on Electrostatics and Magnetism," three volumes of "Mathematical and Physical Papers" (those not yet published will make another), Thomson and Tait's "Treatise in Natural Philosophy," in two volumes, and three volumes of Popular Lectures and Addresses. Of these many papers the majority are not of an experimental character, and Kelvin's experimental work that will be best remembered is probably comprised in his discovery of the Joule-Thomson cooling effect in gases and of the Thomson effect of the carriage of heat with or against the electric current.

Kelvin's great strength consisted in his mastery of the application of mathematical methods, and of mechanics in particular, combined with his rare physical intuition and his ability to construct models to make difficult phenomena tangibly realizable. Helmholtz says of him in his preface to his translation of Thomson and Tait, "William Thomson, one of the most penetrating and ingenious thinkers, deserves the thanks of

the scientific world, in that he takes us into the workshop of his thoughts and unravels the guiding threads which have helped him to master and to set in order the most resisting and confused material." Again in his "Report on Sir William Thomson's Mathematical and Physical Papers" he sees the great merit of Thomson's scientific methods in the fact that, "following the example given by Faraday, he avoids as far as possible hypotheses about unknown subjects and endeavors to express by his mathematical treatment of problems simply the law of observable phenomena. By this circumscription of his field Thomson brought out the analogy between the different phenomena of nature much more clearly than would have been the case if it had been complicated by widely diverging ideas with reference to the inner mechanism of phenomena."

Though Kelvin is often mentioned as a mathematician, this is not correct in the strict sense, inasmuch as he did not add to the methods of mathematics proper. Indeed, it is very doubtful if he knew any more of mathematics at eighty than he did at twenty. He did not need to. For him a thorough familiarity with the methods of Lagrange, Fourier, Cauchy and Green amply sufficed. We never hear him mention a Riemann's surface or an existence-theorem. This we say not as a reproach, nor as an insinuation regarding the fertility of modern pure mathematics, but merely as an interesting fact. These methods may be taught, and in a reasonable time. Let us in America pray for teachers of this science which Helmholtz calls "die eigentliche Basis aller rechter Naturwissenschaft," of the inspiring quality of Lord Kelvin, the high priest of that most alluring goddess of the natural sciences, MATHEMATICAL PHYSICS.

ARTHUR GORDON WEBSTER
CLARK UNIVERSITY,
December 22, 1907

MEDICINE AND THE UNIVERSITY[1]

I BELIEVE that I make no mistake in assuming that the honor of the invitation to deliver this address came to me mainly through the official position which I chance to hold in the Association for the Advancement of Science and the desire to give prominence on this occasion to the sciences of nature in view of the approaching meeting of the association in this place. I must, however, disclaim any especial competence to speak for these sciences, and I know not where there is less need in our country of emphasizing the importance and significance of the natural and physical sciences, or where the representatives of these sciences have brought higher distinction to themselves and to their university, than here in the University of Chicago.

The past century is memorable above all others for the gigantic progress of the natural and physical sciences—a progress which has influenced more profoundly the lives and thought, the position and prospects of mankind, than all the political changes, all the conquests, all the codes and legislation. In this marvelous scientific advancement in all directions the sciences of living beings and their manifestations have progressed as rapidly and have influenced the material, intellectual and social conditions of mankind as much as the sciences of inanimate matter and its energies. So far as the happiness of human beings is concerned, there is no other gift of science comparable to the increased power acquired by medicine to annul or lessen physical suffering and to restrain the spread of pestilential diseases, although what has been accomplished in this direction is small indeed in comparison with what remains to be achieved. Man's power over disease advances with increased knowledge of the

[1] An address delivered at the convocation exercises of the University of Chicago, December 17, 1907.

nature and causes of disease, and this increase of knowledge has its sources in the educational system.

In asking your attention on this occasion to some of the conditions and problems of medical education and research, particularly in their relation to the university and to circumstances existing in this country, I am aware that the theme is trite and that I can add little that is new to its discussion, but the subject, however wearisome, requires ever renewed consideration so long as the conditions remain as unsatisfactory as at present and so many problems await final solution. Especially is it important that the nature of the problems should be realized by the teachers and authorities of our universities. I know that in this university much earnest thought has been given to questions of medical education, and wisely so, for I have every confidence that the medical department of this university, already doing such good work, is destined to be a leader in the promotion of higher medical education and the advancement of medical knowledge on this continent.

The historical and the proper home of the medical school is the university, of which it should be an integral part coordinate with the other faculties. Before there was a faculty of law at Bologna or of theology at Paris there was a school of medicine at Salernum, which, as is well known, occupies an interesting and unique position in the history of the origin and development of universities. From this early period to the present day no other type of medical school has existed on the continent of Europe than that of the university, and this union has been of mutual advantage, the renown of many universities being due in large part to their medical faculties, and these receiving the fostering care and the ideals of the university.

It was under the influence of these sound traditions of the proper relation of medical teaching to the universities that the first medical schools in this country were founded, that of the College of Philadelphia, now the University of Pennsylvania, in 1765; that of Kings College, now Columbia University, in 1767, and after somewhat longer intervals those of Harvard, Dartmouth and Yale. The model for these early schools was the medical department of the University of Edinburgh, which derived its traditions from the University of Leyden, as these in turn can be traced back to the great Italian universities of the sixteenth century. We can contemplate with much pride and satisfaction the early history of these first American medical schools, which, notwithstanding their feeble resources, were imbued with a spirit of high purpose and just recognition of the qualifications needed for the pursuit of medicine as a learned profession.

It is deeply to be regretted that their successors did not continue to build on such foundations as those laid by John Morgan, William Shippen and Samuel Bard, but rather adopted and carried much further the plan of the proprietary medical schools which originated in England in the latter part of the eighteenth century and attained their highest development there during the first three decades of the following century, after which the hospital medical schools of a type peculiar to that country gained the ascendancy. We can transfer from our shoulders, however, only a minor part of the responsibility for the conception and establishment of the proprietary medical school, for the English form of this school was a harmless thing which never dreamed of conferring the doctor's degree and was regarded with disfavor by examining and licensing bodies.

The proprietary medical school, conducted for gain, divorced from any connection with a university and free from

any responsible outside control whatever, empowered by the state to usurp the university's right of conferring the doctor's degree and at liberty to set whatever standards it chose for obtaining this degree, which carried with it the license to practise, is a phenomenon unique in the history of education and a contribution to systems of education for which America is entitled to the sole credit. This is the type of medical school which prevailed in this country during the greater part of the nineteenth century, and familiarity has made it difficult for us fully to realize how anomalous and monstrous it really is. Even in the case of those schools which were united with a college or university the connection became in most instances so loosened as to be merely nominal and to secure practical autonomy to the medical school. In the common type of these schools there was no requirement of preliminary study worthy of the name, the only practical training was in the dissecting room and an occasional amphitheater clinic, and the degree and license to practise followed the passing of an easy examination after attendance on two annual courses of lectures lasting five or six months each, sometimes an even shorter period, the student hearing the same lectures each year.

It is needless to say that such conditions brought great reproach to American medicine and introduced evils from which we are not yet wholly free. Nevertheless the system, bad as it was, can be painted in too dark colors. The rapid multiplication of medical schools which followed the second decade of the last century was, although excessive, in response to the needs of a rapidly developing country pushing the boundaries of civilization ever westward. Still it would be difficult to find a sound argument for increasing the hardships of frontier settlements and struggling communities by a supply of poor doctors.

The main relief to the picture is that the results were not so bad as the system. Many of the teachers were devoted, able men who imparted sound professional traditions and whose personality in a measure remedied the defects of the system. The native force, ability and zeal of many students enabled them to overcome serious obstacles and to acquire in the course of time, in spite of adverse circumstances, a mastery of their calling, perhaps a resourcefulness engendered by these circumstances, for even under the best conditions education does not end with the modicum of knowledge imparted in school and college. Some were so fortunate as to be able to supplement their inadequate training by European study. But among those without foreign training who were entirely the products of American conditions not a few were the peers of their European contemporaries, such as Daniel Drake, Jacob Bigelow, John D. Godman, William Beaumont, Nathan Smith Davis, Samuel D. Gross, Austin Flint, Marion Sims and others who have left names illustrious in the annals of our profession. Native vigor and resourcefulness enabled such men to surmount defects of an educational environment to which the average man must succumb.

Most gratifying is the rapidity with which medical education has risen during the last two decades from the low estate to which it had sunk during the greater part of the past century in this country. Among the more important causes contributing to this result may be mentioned the operation of laws transferring and, in fact, restoring the licensure to practise from the medical schools to state boards of examiners, whereby worthless medical schools are crowded to the wall and out of existence and others have been com-

pelled to raise their standards, the moral pressure exerted through an awakened sentiment for reform on the part of the organized profession and the better schools, closer union between medical school and university and the consequent interest of university teachers and authorities in the problems of medical education, the example set by a few schools of a high order, endowment—although very inadequate—of medical education, which formerly was almost wholly neglected as an object in need or worthy of private or public beneficence, the advancement of medical science and art, necessitating improved methods and higher standards of professional training, and a juster and wider appreciation of the significance of curative and preventive medicine to the welfare of the community.

The history of medical education in America is still in the making, but we now have a number of schools with high standards and adequate equipment capable of giving to students of medicine a professional education as good as that to be obtained in European universities. The best and most progressive schools are those in organic union with a university, and it seems clear that to schools of this type belongs the future of higher medical education in this country. Nearly twenty years ago in an address at Yale University I endeavored to set forth the advantages of the union of medical school and university, and, as addresses, fortunately for those in the habit of giving them, are soon forgotten, I shall here summarize what I conceive to be the more prominent of these advantages.

Of all professional and technical schools the medical, with its requirements for laboratories, hospitals and teaching force, is the most costly. A medical department of a university is much more likely to be the recipient of endowment funds than an independent school, and the university is a safer and more suitable custodian of such funds.

In manifold ways the environment of a university is that best adapted to the teaching and the advancement of medicine. The medical school needs the ideals of the university in maintaining the dignity of its high calling, in laying a broad foundation for professional study, in applying correct educational principles in the arrangement of the curriculum and in methods of instruction, in assigning the proper place and share to the scientific and the practical studies, in giving due emphasis to both the teaching and the investigating sides of its work, in stimulating productive research, and in determining what shall be the qualifications of its teachers and of the recipients of its degree. Most invigorating is the contact of medical teachers and investigators with workers in those sciences on which medicine is dependent—chemistry, physics and biology.

In the selection of teachers—a matter of the first importance—a university is in a superior position to secure the best available men wherever they can be found, regardless of any other consideration than fitness. Too often this choice has been determined in our medical schools by irrelevant influences and considerations and an outlook upon the world scarcely more than parochial in extent.

In the difficult matter of adjustment of professional training to conditions of collegiate education peculiar to our country there are manifest advantages in the union of medical school with university, especially where the periods of liberal and of professional study are made to overlap. Where the sciences adjuvant to medicine, as general chemistry, physics, zoology and botany, are included in the medical curriculum, as is done in the German and French universities, it is economical and

highly desirable that they should be taught in the collegiate or philosophical faculty rather than that separate provision should be made for them in the medical faculty, where they do not properly belong.

The benefits of union of medical school and university are reciprocal, and not to the medical school alone. A good medical faculty, properly supported and equipped, is a source of strength and of renown to the university possessing it, and its work in training students and in extending the boundaries of knowledge greatly increases the usefulness of the university to the community. Nor is there anything in this work which does not appertain to the proper functions of a university, however high its ideals. Indeed I venture to assert that the present and prospective state of medicine and its relations to the well-being of individual man and of human society are such that there is no higher or nobler function of a university than the teaching of the nature of disease and how it may be cured and prevented, and the advancement of the knowledge on which this conquest of disease depends. If it be said that the medical art is largely empiric, I reply that this, while true, does not make medicine unworthy of shelter in the university. The empiric method of discovery by trial and error has its glorious triumphs as well as the scientific and is not to be disdained. To it we owe such beneficial discoveries as the curative properties of quinine in malaria, vaccination against smallpox and the anesthetic uses of ether and chloroform.

But there is a scientific as well as an empiric side to medicine and the distinctive feature of modern medicine is the rapid extension of the former and the curtailment of the latter. The fundamental medical sciences—anatomy, physiology, physiological chemistry, pathology, pharmacology, bacteriology and hygiene—are rapidly advancing and important departments of biological science, which have contributed and will continue to contribute enormously to the progress of practical medicine. In an address which I had the honor to deliver somewhat over ten years ago at the dedication of the Hull Biological Laboratories of this university I took occasion to dwell with some detail upon the biological aspects of medicine.

We should add to the specialized medical sciences already mentioned the study of the problems presented by the living patient in hospitals and laboratories attached to hospital clinics where chemical, physical and biological methods can be applied to the investigation of clinical problems, which do not fall within the scope of other laboratories or can be less advantageously attacked in them. These clinical investigating laboratories are an important addition to the older analytical and statistical methods of study of disease and mark an advance from which valuable results have been obtained and more valuable ones are to be expected. It is highly desirable that our medical clinics should be organized with regard to this newer direction of work, for which they will require considerable funds.

The science of medicine has advanced in recent years more rapidly than the art and in its various branches it constitutes to-day a field of work most alluring and most rewarding to the properly trained scientific investigator, who, if he have the rare genius for discovery, may reap a harvest rich in blessing to mankind.

But the art of medicine has profited greatly by the application of scientific discoveries. The physician and the surgeon to-day can do far more in the relief of physical suffering and in the successful treatment of disease and injury than was formerly possible, but the great triumphs have been in the field of preventive medicine. The horizon of the average man's

interest in medicine scarcely extends beyond the circumference of his own body or that of his family, and he measures the value of the medical art by its capacity to cure his cold, his rheumatism, his dyspepsia, his neurasthenia, all unconscious, because he does not encounter them, of the many perils which medicine has removed from his path through life. What does he know of the decline in the death rate by one half and of the increase in the expectation of life by ten or twelve years during the last century? How many are there whose attention has been called to the significant fact that this increase in the expectation of life ceases with the forty-fifth year because we have as yet no such insight into the causes and prevention of the organic diseases of advancing life as we have into the manner of propagation of infectious diseases, which are responsible for the larger part of the mortality of the earlier years? The suffering and the waste of energy, money, production and human lives from preventable sickness and death are still incalculable, but how little heed do legislators and authorities in our national, state and municipal governments pay to the appeals of physicians and enlightened economists to make adequate provision to check this waste! For this condition of things the medical profession is largely responsible in failing to enlighten the public and in shrouding its art with the mystery of an occult science, but it is beginning to rise to its high mission of public education in ways of preserving health and of preventing disease.

I have touched on these matters relating to the present and future state of the science and art of medicine, not with the view of recounting the achievements of modern medicine, but to indicate something of their importance to individual and to civic life and to show that in fostering the teaching and study of medicine the university finds a field worthy of its highest endeavors in the propagation of useful knowledge and in service to the community.

From what has been said we may, I think, assume with confidence that the best and in time the prevailing type of American medical school is destined to be that represented in medical departments in vital union with universities. In so far our system of medical education will conform to that of Germany and France, but in an important respect there is and will doubtless remain a difference due to the fact that in those countries the courses of study and the qualifications for the degree and the license to practise are moulded into practical uniformity by the regulations of the state. Nothing is more characteristic of the conditions of medical education in our country than the great diversity of the requirements and curricula of the various medical schools, even of those of the better sort. Entire uniformity is not to be expected and not to be desired, but at least such a measure of agreement should be secured as will permit students to pass freely from one university to another and to acquire, it is to be hoped, something of the habit of wandering which is such an enviable feature of student life in the German universities.

No problem of medical education in this country is so perplexing or has given rise in recent years to so much discussion and difference of opinion as that of the preliminary education to be required for the study of medicine. If I could announce a universally satisfactory solution of this problem, I should claim the honors of an important discovery, but as I can not do so I shall forego on this occasion its detailed discussion, with a self-sacrificing forbearance which I trust may be commended by my hearers. It must suffice to enumerate the attempts at a solution, premising, what is generally recognized, that the difficulties

arise from the anomalous development of the American college for many years, making it, however admirable it may be for certain educational uses, almost unadjustable to the needs of professional education.

The preliminary requirement of the bachelor's degree in arts or science should, in my judgment, carry with it the specification of collegiate laboratory training in physics, chemistry and biology, with a reading knowledge of French and German. These requirements have been in successful operation in the medical department of the Johns Hopkins University since its foundation in 1893, their adoption being necessitated by the acceptance of the terms of Miss Garrett's gift of endowment. We are satisfied with the working of these requirements and would not lower them if we could, but it must be conceded that, while there is room for medical schools with these standards, the country is not ripe for their general adoption. The medical department of Cornell University has recently announced the intention to introduce similar requirements, and the Harvard University Medical School demands the bachelor's degree without the other requirements mentioned.

In order to meet the objection that the average age of graduation from our colleges is at least two years beyond that at which professional study usually begins in Europe, various attempts have been made to truncate the college course or to telescope a quarter to a half of it into the period of professional study, making one course of study count for two degrees. Manifest objections and embarrassments attend all of these attempts to find a suitable stopping place between the high school and the end of the college course. The plan adopted in this university to demarcate with some sharpness the first two years of the college course from the remainder and to exact the completion of these two years of study as the requirement preliminary to the study of medicine has much to recommend it under existing conditions. I learn from the last report of the Council on Medical Education of the American Medical Association that one medical school, the medical department of Western Reserve University, demands as a prerequisite to the study of medicine three years of study in a college of arts or science, sixteen require two years of collegiate study, eleven of these schools being in the middle west or west, and thirty-one require one year, of these, nineteen being in the middle west or west.

The Council on Medical Education just mentioned, of which Dr. Bevan is the energetic and efficient chairman, has entered as a strong force for the elevation of standards of medical education in this country, and, while it has not the power of the British General Medical Council to make effective its recommendations, it can exert a most beneficial influence. It is significant that at its first conference, held in 1905, it recommended as the minimum preliminary requirement to be generally adopted by our medical schools an education sufficient to enable the student to enter the freshman class of a recognized college of arts or a university, and now it recommends that in 1910 to this shall be added a year's study of physics, chemistry and biology, with one modern language, preferably German. The time has gone by when it is necessary to emphasize before an audience such as this the importance of laboratory training in physics, chemistry and general biology as fundamental to the successful study of medicine.

While it is not feasible to exact the preliminary study of the ancient classics, save some acquaintance with Latin, I feel that they are of value to the physician and that a liberal education and broad culture raise

the influence and standing of the physician in the community, enhance and widen the intellectual pleasures of his life, instil an interest in the history of medicine and give him greater joy in the pursuit of a noble profession. It is important, especially for medicine, that this culture be imparted by methods of liberal education which do not blunt man's innate curiosity for the facts of nature.

There can be no more striking evidence of the progress of medical education in this country during the last quarter of a century than that it is no longer the laboratory, but the clinical side of medical teaching which offers the urgent problems. Only a few years ago the cry was the need of laboratories; now, while a sufficient supply of good laboratories is still beyond the resources of many medical schools, their value is fully recognized and all of our better schools possess them and are devoting probably as much of the time and energies of teachers and students to work in the laboratories as is desirable. There is even some risk, I believe, that a subject which can be studied with facility and advantage in a laboratory may acquire, on this account, a position in the scheme of medical studies disproportionate to its relative importance. The structure of organized beings, normal or diseased, for example, is eminently adapted to laboratory study, and for centuries normal anatomy had an educational value all its own, because it was the only subject which students were taught in the laboratory, whereas the study of function, certainly not less important, is much more difficult to approach by the laboratory method, and even at the present time normal physiology and especially pathological physiology do not receive the attention in medical education to which their importance entitles them.

It is interesting to note the impressions which Professor Orth, of Berlin, an acute observer and most competent judge in all matters pertaining to medical education, received from his visit to this country three years ago regarding our laboratories and clinics. In an address conveying these impressions to the Berlin Medical Society he expresses his astonishment and satisfaction that, in contrast to the prevalent opinion in Germany as to our medical schools, he found that fully as much emphasis is placed on laboratory teaching here as there, that the laboratories which he visited are as good, their arrangements in some instances arousing his envy, and the methods of teaching practically the same as in Germany, whereas he gathered the impression that the opportunities and methods of clinical teaching are less satisfactory than in Germany and not commensurate with those of our laboratories.

I do not desire to instil sentiments of undue complacency regarding the condition of laboratory teaching in our medical schools, for there is still room for much improvement in this regard. Many schools are sadly deficient and even the best have not all that is needed in the supply and maintenance of laboratories, but the time has come to give especial emphasis to directions of improvement in the teaching of practical medicine and surgery. The making of good practitioners should always be kept to the front as the prime purpose of a medical school.

I believe that in most medical schools at present the clinic falls behind the laboratory in affording students opportunities for that prolonged, intimate, personal contact with the object of study, in this instance the living patient, which is essential for a really vital knowledge of a subject. To secure this, amphitheater clinics and ward classes alone do not suffice, valuable as these are, but students under suitable restrictions and supervision and at the proper period in their course of study should work in the

dispensary and should have free access to patients in the public wards of hospitals, acting in the capacity of clinical clerks and surgical dressers as a part of the regular, orderly machinery of the hospital.

In order to place the clinical side of medical instruction on the same satisfactory foundation as that of laboratory teaching, two reforms are especially needed in most of our medical schools.

The first is that the heads of the principal clinical departments, particularly the medical and the surgical, should devote their main energies and time to their hospital work and to teaching and investigating without the necessity of seeking their livelihood in a busy outside practise and without allowing such practise to become their chief professional occupation. This direction of reform has been forcibly urged in this city and elsewhere by my colleague, Dr. Barker, whom we have reclaimed from you, in notable papers and addresses.

The other reform is the introduction of the system of practical training of students in the hospital, which I have indicated, and with it the foundation and support of teaching and investigating laboratories connected with the clinics, to which I have already referred, necessitating the possession of a hospital by the medical school or the establishment of such relations with outside hospitals as will make possible these conditions. This subject, as thus outlined, I made the theme of an address at the opening, six months ago, of the new Jefferson Medical College Hospital in Philadelphia, and I shall now recur only to the point which I endeavored there to establish, that the teaching hospital subserves the interest of the patient not less than that of the student and teacher and is the best and most useful kind of public hospital.

Hospitals make generally a stronger appeal to public and private philanthropy than the support of medical education, but I do not hesitate to affirm that a general hospital in a university city, whether maintained by public funds or by private benevolence, serves the community and the interests of its patients far better when it is readily accessible and freely available for the purposes of medical education than when it is divorced from connection with medical teaching. Witness the great public hospitals in Vienna, Berlin, Munich, Leipsic, Paris, London, Edinburgh, Dublin and a few in this country. It is most deplorable both for the hospitals and for the medical schools that these two institutions, which should be linked arms of medical education, should have developed in this country so far apart, that state and municipal authorities and private founders should have so little realization of the inestimable advantages which close association with a good medical school can confer on a hospital, and that the immense possibilities of public hospitals in our large cities for the education of students and physicians and for the advancement of medical knowledge should be utilized to so small an extent, often not at all.

It would be one of the greatest benefits to the cause of higher medical education if the University of Chicago, for its medical department, should come into possession of a good general hospital and fortunate the hospital which enters into this relationship. This university, the source of so many important contributions to the advancement of knowledge and of higher education, will then be, in larger measure than it now finds possible, a center of similar service to medicine.

Medical education partakes fully of the freedom, so amazing often to many of our European colleagues, with which we unhesitatingly try all sorts of educational experiments in this country—it is to be hoped and expected for the ultimate benefit of systems of education, whatever the im-

mediate results may be in individual cases. The theme of this address naturally suggests many topics relating to methods of teaching and to the medical curriculum which are questions of the day, but which I must lay aside through lack of time. On one only I beg to say a few words.

In contrast to the German system, the tendency in our American medical schools has been toward a rigid curriculum, which, though widely divergent in different schools, is to be followed in precisely the same way by all students without any consideration of differing ability, capacity for work, special aptitudes and interests. One of many unfortunate results is that subjects and courses of study which can not properly be imposed as obligatory on already overburdened students find no place in our medical schools, which should aim to cultivate the whole field of medicine. I agree with Dr. Bowditch and my colleague, Dr. Mall, to whose admirable presentation of this subject I would refer those interested, that our students should have a greater latitude of choice than is now customary in subjects to be pursued, in the amount of time to be devoted to their study and in the order in which they may be taken. Complete freedom can not be granted. A minimum requirement for the principal subjects must be made obligatory, but if this minimum is properly fixed there remains room for a considerable range of choice of subjects and courses, greatly to the advantage of student and teacher. At the Harvard Medical School the system of electives for the fourth year of the course has been in operation for several years, and other medical schools have also introduced a similar plan. At the beginning of the current academic year we adopted at the Johns Hopkins Medical School a scheme by which a large number of elective courses are offered throughout the four years, and the plan is now working most successfully.

Some of our state boards of examiners are greatly exercised over the differences which they find in the curricula of the various medical schools in this country, and which in themselves are merely an indication that there is, and, in my judgment, there can be no agreement of opinion as to every detail of a medical curriculum. There are doubtless defects to be remedied, but in attempting to apply remedies these state boards should concern themselves with no other question than that of educational standards. They could make no greater mistake nor inflict more serious injury on the efforts of the better schools to improve their methods of teaching than to attempt to impose a uniform and rigid obligatory curriculum on all schools. They do not in their examinations apply any practical tests whatever to determine the candidate's fitness for the practise of medicine, whereas our better schools are exerting every effort to increase their efficiency by substituting practical work in laboratories, hospital wards and out-patient departments for didactic lectures. The work of students who gain their knowledge by serving as clinical clerks and surgical dressers in the hospital can not be measured by time standards in the same precise way as that of attendance on expository lectures. Above all, the better schools should not be hampered by restrictions imposed by state boards of examiners in freedom to extend the system of electives of which I have spoken.

The medical department of a university should be a school of thought, as well as a school of teaching, *academia* as well as *schola*. Although there has been gratifying progress in recent years, our medical schools have not advanced along the path of productive research to the same extent that they have in the way of improvement of their educational work. There are several reasons for this condition. For one

thing we have been too busy setting our houses in order for their primary uses in the training of students to have given the requisite attention to other questions which, however important, may have seemed for the moment less urgent. With the degree of emphasis thus placed on the educational side teaching gifts rather than investigating capacity have been sought as the most desirable qualification of professors in our medical schools. The power of imparting knowledge, gained second-hand, fluently and even skilfully, is not an uncommon gift and is possessed by many who have never engaged in research and have no especial inclination or aptitude for it, but the teaching of him who has questioned Nature and received her answers has often, and I think commonly, in spite it may be of defects of delivery, a rarer and more inspiring quality.

A medical school or university can not expect to fill all of its chairs with men with the genius for discovery—if it has one or two it has a treasure beyond all price—but every effort should be made to secure as occupants of these chairs from among those who are available, wherever they can be found, the ones who have demonstrated the greatest capacity to advance knowledge by original investigation and the ability to stimulate research. Until this principle is more fully and generally recognized and acted on in the selection of heads of departments, our medical schools as a class will not become important contributors to knowledge. It is not enough that a few schools should encourage and provide for original investigation; the field must be a wide one in order to attract many to a scientific career, for of the many only a few will be found endowed with the power of discovery. There is no possible way of recognizing the possessor of this power before he has demonstrated it. Even when a university has succeeded in attaching to it those who can conduct scientific inquiry successfully, how often are their energies sapped by lack of adequate resources and enough trained assistants and by too great burden of teaching and administrative work imposed on them!

It is evident from what has been said, and indeed it has been a tacit assumption throughout this address, that, while with present resources considerable improvement in medical education in this country is possible, further progress is largely a question of ways and means. What makes modern medical education so costly is precisely its practical character, necessitating laboratories and hospitals, and it can be made self-supporting no more than any other department of higher education. For reasons already stated, the medical departments of strong universities are the ones most likely to receive the funds needed for the support of medical education and are in general the most deserving. There is a great future before the medical schools of many of our state universities, which are already developing with such promise and are sure to receive in increasing measure aid from the state as their needs and the benefits accruing to the community from their generous support are more and more fully appreciated. Other universities must look to private endowment, and I have endeavored to show that they should foster their departments of medicine as zealously as their other faculties. The university chest should be opened, so far as possible, to supply needs of the medical school, and authorities of the university should present the claims of medical education to financial aid as among the most important in their domain, and they can do so to-day with a force of appeal not possible a quarter of a century ago. President Eliot, whose services to the cause of medical education are great, in his address at the opening of the new buildings of the Harvard

University Medical School, set forth with admirable force and clearness the changes which advancing medicine has brought in the vocation of the physician, his greatly increased capacity of service to the community and his still higher mission in the future.

The discoveries which have transformed the face of modern medicine have been in the field of infectious diseases, and in no other department of medicine could new knowledge have meant so much to mankind, for the infectious diseases have a significance to the race possessed by no other class of disease and problems relating to their restraint are scarcely less social and economic than medical. The public is awakening to this aspect in the case of tuberculosis, and I need only cite as a further example the necessity of keeping in check the malarial diseases and yellow fever for success in digging the Isthmian Canal, an undertaking in which the triumphs of the sanitarian, Colonel Gorgas, are not outrivaled by those of the engineer. Such victories over disease as those of the prevention of hydrophobia by the inoculation of Pasteur's vaccine and the antitoxic treatment of diphtheria have made an especially strong impression on the public mind.

More than all that had gone before in the history of medicine the results achieved during the last quarter of a century in exploration of the fields of infection and immunity opened by the discoveries of Pasteur and of Koch have stirred men's minds to the importance of advancement of medical knowledge, and medical science at last has entered into its long awaited heritage as a worthy and rewarding object of public and private endowment. But it is to be noted that it is not so much the education of doctors as this advancement of knowledge which makes the strong appeal, as may be illustrated by the splendid foundation of the Rockefeller Institute for Medical Research through the enlightened generosity of the founder of this university, the Phipps Institute for the Study and Prevention of Tuberculosis, and the Memorial Institute for the Study of Infectious Diseases, established in this city by Mr. and Mrs. Harold McCormick, which under the efficient direction of Dr. Hektoen has become a most active and important contributor to our knowledge of infection and immunity.

These magnificent additions to the resources of this country for the promotion of medical investigations are of inestimable value, but not one of them could have justified its existence by results if it had been established in America thirty years ago, when medical education was so defective. The dependence of research on education is of fundamental importance. The prime factor influencing the development of scientific research in any country is the condition of its higher education. Scientific investigation is the fruit of a tree which has its roots in the educational system, and if the roots are neglected and unhealthy there will be no fruit. Trained investigators are bred in educational institutions. Independent laboratories are dependent on a supply from this source, and without it they can not justify their existence, but where proper standards of education exist such laboratories have a distinctive and important field of usefulness. I contend, therefore, that those interested in the advancement of medical knowledge should not be indifferent to the condition of education in our better medical schools and should not rest on the assumption that the educational side can be safely left to take care of itself.

Moreover, those who are to apply the new knowledge are physicians and sanitarians. The public is vitally interested in the supply of good physicians, never so

much as to-day when their power to serve the welfare of the community has been so vastly increased and is rapidly growing, and if it wants good doctors it must help to make them.

I have been able, within the limits of this address, to indicate only a relatively small part of the increased strength gained by both medical school and university by the combination of their forces, but I hope that I may have conveyed some impression of the rich fields of discovery, of the beneficent service to the community, of the important educational work opened to the university by close union with a strong department of medicine, and of the inestimable value to medicine of intimate contact with the fructifying influences and vitalizing ideals of the university. Where is there a university which, if provided with the requisite resources, gives stronger assurance of securing these mutual benefits than the University of Chicago, so fruitful in achievement during its brief but eventful history, so vigorous in its present life, so full of high promise for the future, and where in all this land is there a location more favorable to the development of a great university medical school than here in the city of Chicago? Such a development is bound to come and the sooner it arrives the earlier the day when America shall assume that leading position in the world of medical science and art assured to her by her resources, the intelligence of her people, her rank among the nations and her high destiny.

William H. Welch
Johns Hopkins University

SCIENTIFIC BOOKS

Denatured or Industrial Alcohol. By Rufus Frost Herrick. 8vo, pp. ix + 516. 163 figures. New York, John Wiley and Sons. 1907. Cloth, $4.00.

The preliminary announcements, the contents and the preface of this book were full of promise and the reviewer opened it with great expectations. But, in reading, he experienced a succession of disappointments, and closed it with the sincere wish that he could be excused from the ungracious and uncongenial task of writing the review.

Chapter I. (16 pp.) contains some brief, interesting, historical items, also tables and extracts from consular reports relating to the use of denatured alcohol.

Chapter II. (47 pp.) describes methods of manufacture of alcohol from potatoes, corn, molasses and some other materials. Dr. Wiley's suggestion that cassava root is a promising raw material is not alluded to. There are numerous good cuts of machines. Under the heading "Theoretical *versus* Practical Yields of Alcohol" calculated yields are compared with those actually obtained from different raw materials.

The microorganisms and fermentation are not given space and thoroughness of treatment proportionate to their importance in the industry. The work of Pasteur, Hansen, Buchner, Effront and others, is disposed of in a few lines for each, and no references are added. A small figure in the upper corner of page 42 is the only illustration of yeasts and the magnification is not given. We could readily spare the picture of a floating thermometer (ordinary dairy or bath thermometer) on page 27 and the full-page illustration of "the largest fermenting tank in the world" on page 33, which shows nothing distinguishing it from a railroad water tank surrounded by a group of workmen, in order to make room for a little more information regarding those interesting microorganisms and the investigations done upon them.

There is an unnecessary duplication of some figures. For instance, cuts of ordinary floating hydrometers, the form of which may be assumed to be familiar to most readers, are found on pages 47, 48, 123, 142 and 259. On the other hand, pycnometers, probably less familiar objects and occurring in a greater number of useful forms, are not given one illustration.

Chapter III., upon the distillation and rectification of alcohol (58 pp.), abounds in electro-

types of fractionating flasks and towers used in the laboratory and elaborate cuts of commercial stills.

Chapter IV., on alcoholometry, contains 47 pages, of which 18 are tables for determining per cent. alcohol from the specific gravity—all of which belong in the appendix. It would have been well to insert a table for the conversion of readings on one technical scale into readings on another. The confusion and haziness in the definitions of "proof" alcohol are illustrated by the odd statement on page 123 ". . . (being equal to proof or 53.71 per cent. by volume of water and 50 per cent. by volume of alcohol) . . ."

The use of references and quotation marks is a little haphazard and sometimes one can not tell just what parts of the text are the author's and what parts he is taking bodily from the journals. This is nothing but carelessness and there is not the slightest indication of willful plagiarism. It is particularly noticeable on page 150, where, by the way, two references are given to the *American Chemical Journal* which can not be found in that journal. They are in the *Journal of the American Chemical Society*. There is no objection to reprinting journal articles bodily as is done very frequently in this book, only a journal article presupposes knowledge of technical details which it is the function of such a book as this to impart. There must be explanatory statements to make the article really useful to the average reader; there must be some editing, in other words. Mr. Herrick has not done enough of such editing and the result is that, despite the value of the numerous articles in themselves, the whole is not so instructive as it should be.

Chapter V. (38 pp.) is on the cost of alcohol and of alcohol-distilling plants. We have here many extracts from Bulletins of the U. S. Department of Agriculture and a few selections from the author's private correspondence. A little over one page of text is inserted, quite out of place, for it belongs under the head of the manufacture of alcohol, upon "The Manufacture of Ethyl Alcohol from Sawdust." Considering the possibilities latent in methods for obtaining alcohol from wood, this treatment is very inadequate. Not a single reference is given where more information may be obtained. The same chapter contains six full pages of coordinate paper on which the costs of buildings of different heights are laid off on one axis against length, width, etc., on the other. The information as to the cost of buildings is given elsewhere, and in more convenient form, as parts of general estimates for completed plants. At least five sixths of that space might have been saved and used to describe processes for obtaining alcohol from wood.

Chapter VI., "Alcohol as an Illuminant" (32 pp.). An interesting little historical sketch is followed by statements of the relative costs of lighting by alcohol and by oil. Methods for making photometric measurements are not touched. A simple diagram of the internal structure of an alcohol burner and a careful description would suffice, but there is an overwhelming array of figures showing lamps of different external appearance, hanging lamps, student lamps, bracket lamps, out door lamps, even a cut on page 231 of a gas jet fitted with an ordinary Welsbach mantle. Along here the text reads like a trade catalogue. For instance, on page 222:

> The accompanying cut shows the Phœbus Hanging Billiard Incandescent Alcohol Lamp. This lamp is of beautiful design and furnishes a very agreeable light for its purpose. The style shown is the large model, and is finished in rich reddish brown or sea-green. . . . The ornate hanging Phœbus lamp (Fig. 92) is finished in an exquisite variety of designs. . . . In Fig. 94, p. 224, is shown the beautifully decorated Phœbus Indoor Alcohol Lamp. This lamp is furnished with a rich bead shade, which can be had in any colors desired.

Without a pause we must jump from this style of literature to statements which presume a knowledge on the reader's part of the significance of the symbols "B.T.U." and the merits of the Harcourt pentane lamp as a standard.

Chapter VII., "The Fuel Value of Alcohol," etc. (40 pp.). The Williams bomb calorimeter is the only form of calorimeter described. The calculations and tables are interesting and instructive. There follow cuts of flat-

irons, curling irons, stoves for heating and for cooking, a "sterno-inferno coffee-machine set," and full-page illustrations of a "complete chafing-dish outfit trimmed with genuine ivory" and "teakettle set, trimmed with solid beaded edge."

Chapter VIII., "Alcohol as a Source of Power" (62 pp.). This chapter opens with twelve pages of excellent cuts and descriptive matter furnished by the Deutz Gas Engine Works "through the kindness of their American branch house, the Otto Gas Engine Works." Mietz and Weiss, Weber and Diesel, and Foos engines are illustrated.

Chapter IX., "Laws and Regulations for Denatured Alcohol" (32 pp.), is almost exclusively a compilation of circulars, regulations and acts of several governments; very interesting and useful, but they belong in the appendix.

A page on the recovery of denatured alcohol is forcibly injected into this chapter where it does not belong. The chapter closes with two pages on "spirit varnishes." This lost and forlorn little composition appears to contain all the book has to say upon the many important uses of denatured alcohol in chemical industries. It is indeed strange that a book on denatured alcohol should not give a brief sketch at least of the manufacture of ethyl ether, iodoform, artificial silk or smokeless powders. Chapter X. (14 pp.) gives extracts from consular reports, showing what enormous quantities of denatured alcohol are used for the above purposes in other countries.

Appendix (pp. 375–499). In this are reprinted government regulations, a report of a committee to the British Parliament, etc., all exceedingly interesting material, but almost all of it to be had for the asking and a postage stamp.

The bibliography on page 493 (not 489, as given in the index) is incomplete. Since some French and German titles are included, others should be. For instance, the *Zeitschr. f. Spiritusindustrie,* the German journal devoted to the subject, is not mentioned. Date and place of publication and authors' initials are in several instances omitted. If it is considered undesirable to include prices in a bibliography, the size of the work might be indicated in terms of pages. In his preface the author says: "The scarcity of literature treating the subject of denatured or industrial alcohol is so great that there are practically no books concerning it." The reviewer had occasion to look up the literature of the subject about a year ago and found many more articles than he had the opportunity to read.

The book as a whole has little claim to consideration as a scientific treatise, and its usefulness "practically" is somewhat problematical, although it contains much that is both good and useful, of course. It is a scrapbook made up from a superabundance of electrotypes, plenty of government publications and dealers' catalogues, some journal articles and too few references. It is raw material which one would naturally collect as a preliminary step to writing a book.

S. LAWRENCE BIGELOW

Genera Avium. Edited by P. WYTSMAN. 4to. Brussels, V. Verteneuil and L. Desmet. Part VI., Picariæ.—Fam. Coliidæ. By P. L. SCLATER. 1906 (1907). Pp. 6; pl. I. Part VII., Steganopodes—Fam. Pelecanidæ. By ALPHONSE DUBOIS. 1907. Pp. 4; pl. I. Part VIII., Picariæ—Fam. Musophagidæ. By ALPHONSE DUBOIS. 1907. Pp. 9; pls. II.

Three more parts[1] of this useful work have recently been published, one of which (part VI.), though dated 1906, apparently was not issued until May, 1907. The general treatment is the same as that of preceding parts, and need not again be explained. "Genera Avium" is, of course, not an exhaustive treatise, but the editor, Mr. P. Wytsman, deserves the thanks of ornithologists for his efforts to bring out a work that shall present in convenient, succinct form, the most important points regarding genera and species, with due regard for the results of recent research.

The Coliidæ, or colies (part VI.), a highly peculiar African family allied to the kingfishers, is considered by Dr. Sclater to con-

[1] For a notice of the five previous numbers, *cf.* SCIENCE, N. S., XXIV., 1906, pp. 438–439.

sist of eight species. No subspecies are admitted, notwithstanding that all but two of the species have been subdivided, and we think rightly, by recent authors. The nomenclature is not fully up to date, for two of the species have older tenable names than those here used. A new name, *Colius hæmatonotus,* is given, apparently by inadvertence, in the key on page three, to *Colius castanonotus* Verreaux. Our author refers all the species of this family to a single genus, but, as we have elsewhere shown, *Urocolius* Bonaparte, containing *Urocolius macrourus* and *Urocolius indicus* (= *erythromelon* Auct.), has more than one claim to recognition. The single plate in this part represents *Colius leucocephalus* and details of two other species.

The cosmopolitan family Pelecanidæ (pelicans) (part VII.) comprises, according to Doctor Dubois, the single genus, *Pelecanus,* with eleven forms, three of which he ranks as subspecies. In the case of *Pelecanus californicus,* which he considers a race of *Pelecanus fuscus* (or, as it should be called, *Pelecanus occidentalis* Linnæus), he is probably right; but *Pelecanus thagus* Molina is apparently a distinct species. The plate shows a figure of the somewhat doubtful *Pelecanus sharpei,* together with the heads of four other forms.

The Musophagidæ, or plantain eaters (part VIII.), another characteristic African family, are here referred to seven genera, without subfamilies. The largest genus, *Turacus,* contains twenty-one forms, including several subspecies; but all the other genera are small, none having more than four species. Two of them—*Corythæola* and the recently discovered *Ruwenzorornis*—are monotypic. We are glad to see that Doctor Dubois adopts the original form of the generic name *Chizærhis* Wagler, instead of the emendation *Schizorhis* so much in vogue. No new forms are described in this number. The two plates illustrate nine species.

HARRY C. OBERHOLSER

SCIENTIFIC JOURNALS AND ARTICLES

The American Museum Journals for November and December are both out containing much information in regard to the work of the Museum. There is a new departure in the shape of colored plates, one showing a boulder containing a deposit of precious opal on quartzite, the other the group of wild turkeys recently placed on exhibition. The December number contains accounts of the expeditions made in 1907 to obtain material for bird groups, of the making of an Attu basket, and of an ant-hunting trip to Europe. It also comprises the Index to Vol. VII.

The Bulletin of the Charleston Museum for November continues the "History of the Museum" by William G. Mazyck and covers the period from 1798 to 1850. We find here many notable and well-known names, such as Gibbes, Holmes, Holbrook, Bache, Maury and Twomey.

Bird Lore for November-December is of unusual interest and contains illustrated articles on "A Thrashing by Thrashers" by Herbert K. Job, "Around the Horn for Petrels" by John T. Nichols, "The Heath Hen" by George W. Field, "A Season's Field Work" by Frank M. Chapman, and the "Migration of Flycatchers" by W. W. Cooke. The number comprises a long and interesting Report of the Work of the Audubon Societies by the President, William Dutcher, and various Special Agents. This should be read by everyone.

The Museums Journal of Great Britain for November notes the gift to Bournemouth of the residence and collections of Mr. Cotes to form an Art Gallery, another of the many instances where collections made by men of wealth have eventually found their way to the public. W. W. Watts discusses "Some Uses of a Museum of Industrial Art," noting the importance of arousing interest in artistic objects, by showing their historical associations or the conditions under which they have been made. A. B. Meyer presents "Some Notes on the Peacock in Display" showing that the position of the wings may be different in different individuals.

SOCIETIES AND ACADEMIES

THE INDIANA ACADEMY OF SCIENCE

THE winter meeting of the academy was held in the Shortridge High School at In-

dianapolis, November 28 and 29. President D. M. Mottier presided and, at the opening session, delivered an instructive and interesting address on "The History and Control of Sex." The following papers were read either in general session or in the sectional meetings formed by grouping related subjects:

GENERAL

"The Origin of Adaptation in the Fresh-water Fauna," by C. H. Eigenmann.

"Spectacles—A Concession to the Theory of Evolution," by A. G. Pohlman.

"New Science Laboratories in Moore's Hill College," by A. J. Bigney.

"A Study of the Sex Ratio in the Fruit Fly," by W. J. Moenkhaus.

"Some Photographs (lantern slides) of Daniel's Comet, 1907," by W. A. Cogshall.

"The Celebration by the New York Academy of Sciences of the Two-hundredth Anniversary of the Birth of Linnæus," by G. W. Wilson.

"Hand Dexterity," by A. G. Pohlman.

"The Autopsy in Relation to the Public Health," by H. R. Alburger.

"An Investigation of the Fuel Value of Indiana Peats," by R. E. Lyons.

ZOOLOGY

"Tardy Humming Birds," by W. B. Van Gorder.

"The Moulting Mechanism of Lizards" (lantern slides), by H. L. Bruner.

"A Crow Roost near Remington, Ind.," by F. J. Breeze.

"The Relation of the Degree of Injury to the Amount of Regeneration and the Moulting Period in Gammarius," by Mary Harman.

"The Influence of Environment on Man," by Robert Hessler.

"Some Internal Factors controlling Regeneration in Scyphomeduson, *Cassiopea Xamachana*," by Charles Zeleny.

"Selective Fertilization in Certain Fishes," by W. J. Moenkhaus.

"Heredity in the Tumor Cell," by H. R. Alburger.

"The Circulation through the Fetal Mammalian Heart," by A. G. Pohlman.

"The Technique of the Three-dimension Reconstruction Model," by A. G. Pohlman.

"Experiments on the Rate of Regeneration," by M. M. Ellis.

"Observations on the Senses and Habits of Bats," by W. L. Hahn.

"Some Notes on the Habits of the Common Box Turtle," by Glen Culbertson.

BOTANY

"The Peronosporates of Indiana," by G. W. Wilson.

"The Existence of *Rœstelia pencillata* and its Teliosporic Phase in North America," by F. D. Kern.

"The Heterotype Chromosomes in *Pinus* and *Thuja*," by I. M. Lewis.

"Insect Galls of Indiana," by Mel T. Cook.

GEOLOGY

"A Probable Origin of the Small Mounds of the Mississippi and Texas Regions," by A. B. Reagan.

"Indiana Soil Types," by C. W. Shannon.

"Structures in the So-called 'Huron' Formation of Indiana, induced by the Solution of the Mississippian Limestone Beneath," by J. W. Beede.

"Stratigraphy of the Richmond Formation of Indiana," by E. R. Cummings.

"Some Peculiarities of the Valley Erosion of Big Creek and its Tributaries in Jefferson County," by Glen Culbertson.

PHYSICS

"The Cause of Surface Tension," by A. L. Foley.

"Loss of Weight in Chemical Reactions," by J. B. Dutcher.

CHEMISTRY

"The Electrolytic Production of Selenic Acid from Lead Selenate," by F. C. Mathers.

"Some Complex Ureids," by James Currie.

"Thiocarbonylsalicylamide and Derivatives," by R. E. Lyons.

"The Volumetric Determination of Selenic Acid," by R. E. Lyons.

The attendance at the meetings was about seventy-five and the interest shown in the work being done in the state was above the average. New members were elected and the treasurer's report showed a satisfactory condition of the finances. Professor Amos W. Butler, secretary of the state board of charities and one of the oldest members, called attention to the fact that two years hence would occur the quarter centennial anniversary of the organization of the academy, and suggested the desirability of a meeting befitting the occasion. As a result plans were started looking to the celebration of the event. The academy's library, which now numbers several thousand volumes

of books and pamphlets, was consigned to the care of the state librarian, who is to catalogue and shelve the collection, and make it as available for use by the members and the public as is any part of the library. The academy reserves the right to remove the collection at any time under certain stipulated conditions.

A discussion of the general welfare of the academy developed the need of bringing more of the science men into closer touch with the work of the academy, and of extending its influence to every part of the state. For this work a committee was appointed whose duty it is to devise a way of bringing the work of the academy more directly to the attention of the scientists. And as a further means to the same end it was decided to hold the winter meetings at different educational centers instead of at Indianapolis, which for years has been the stated meeting place. Finally, it was the general feeling that interest would increase if the state appropriation for publishing the *Proceedings* could be increased so that the papers would appear in a more extended form and if separates of the papers could be secured at a more reasonable price. The summer meeting was discontinued for the present.

JAMES H. RANSOM,
Secretary

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 639th meeting of the society was held November 23, 1907—President Hayford in the chair. Mr. Fred E. Wright spoke of "Recent Improvements in the Petrographic Microscope" describing briefly the most important improvements which have been made in the petrographic microscope during recent years. The different attachments and accessories were considered especially with reference to their general applicability and the degree of accuracy attainable by their use. The speaker explained that the improvements had been chiefly brought about by the demands of geologists and mineralogists. The optical principles involved in the study of minerals, and how these can be applied in mineral classification, were briefly defined. With the microscopes now available it is possible to measure the refractive index of mineral grains that are only a few thousandths of a millimeter in diameter. Special mention was made of the double micrometer ocular for determining optic axes of minerals. By its aid the optical angle can be measured to one degree if both axes are visible, or to 3° if only one is visible. Special appliances were also shown for measuring the extinction angle by the use of which the best accuracy attainable is from 10′ to 15′.

Mr. W. P. White presented a paper on "Calorimetric Measurements within the Electric Furnace." The special furnace which it was proposed to use in the high temperature measurements, and the conditions which the electric furnace imposes on high temperature problems were briefly mentioned. The difficulty of obtaining a good calorimeter was pointed out.

The method of dropping heated bodies from a furnace into a calorimeter is familiar and satisfactory, but fails to give many inversion —and latent heats which require to be determined on a rising temperature. Dropping into a furnace or manipulation with it is exceedingly difficult. By measuring the heat flowing into a crucible by means of the difference of temperature between crucible and furnace wall, a new and simple radiation method is obtained. In a preliminary survey, this method was satisfactorily applied to 2-gram charges of silicates as high as 1560°. The temperature rose 8° a minute; the temperature difference (furnace wall—crucible) was about 3°, which was measured to 0.1°. Results agreed within six per cent. By keeping the temperature difference constant and varying the rate, systematic errors in the reading of the thermoelements were avoided. This method compares the latent with the specific heat, which is then to be determined by the dropping method.

R. L. FARIS,
Secretary

THE TORREY BOTANICAL CLUB

THE meeting for November 27, 1907, was called to order at the Museum Building of the New York Botanical Garden at 3:45 P.M. by the secretary, and Dr. N. L. Britton was

elected chairman. Nineteen persons were present.

Mr. G. V. Nash exhibited a flowering specimen of the orchid *Masdevallia bella*. The Rev. Leander T. Chamberlain read an extract copied from the Province Laws of Massachusetts, 1736–1761, p. 153, entitled "An Act to Prevent Damage to English Grain, arising from Barberry Bushes." All persons in the province having barberry bushes growing on their land, were ordered to destroy them before a named date. Severe penalties were prescribed on failure to comply with this law. A brief discussion of the subject followed.

Dr. Britton exhibited a specimen from Jamaica, W. I., illustrating an economic use of cat-tails. This was a "bed," made from the split stems of the *Typha domingensis*.

The following scientific program was presented:

A New Utricularia from Long Island: John Hendley Barnhart.

The new species was described and specimens of it exhibited. The paper and description will be published in full in the *Bulletin of the Torrey Botanical Club,* for December, 1907.

Some Anomalous Leaf-forms: C. Stuart Gager.

Specimens were shown illustrating the formation of ascidia in the white (?) clover and in a leaflet of the licorice (*Glycyrrhiza*); variations in the branching of the leaf-blade of a species of *Fraxinus;* transitions, in *Aralia racemosa,* from a once-compound to a normally twice-compound leaf; branching of the leaflets of *Hicoria ovata* and of *Æsculus hippocastanum;* and various stages of transition, in *Gleditschia triacanthus,* from once-compound leaves to twice- and thrice-compound ones, the transitional forms occurring in some instances on the same branch, and even on the same leaf. Rosette leaves were also shown from several species of Biotian asters, showing gradual transitions from a slight indentation of the margin of the blade along its basal half to the development of petiolate leaflets, so that the leaf appeared to be a pinnately compound one. The possible causes of these variations were briefly discussed.

Brief discussion followed the presentation of both papers.

C. Stuart Gager,
Secretary

THE AMERICAN CHEMICAL SOCIETY. NEW YORK SECTION

The third regular meeting of the session of 1907–8 was held at the Chemists' Club, 108 West 55th Street, on December 6.

Messrs. T. J. Parker, L. H. Baekeland, Hugo Schweitzer, G. C. Stone, E. G. Love and Morris Loeb were elected to represent the section in the council of the society.

The following papers were read:

The Relative Solubility of Silver Halides and Silver Sulphocyanate: Arthur E. Hill.

The solubilities of silver chloride, sulphocyanate, bromide and iodide are compared by the method of solution equilibrium; when silver chloride, for example, is treated with a solution of potassium sulphocyanate a partial decomposition of the chloride occurs, as shown by the expression

$$AgCl + KCNS \rightleftarrows AgCNS + KCl.$$

According to theory,

$$\frac{S_1}{S_2} = \sqrt{\frac{C_1}{C_2}}$$

where S_1 and S_2 stand for the solubilities of the two difficultly soluble salts, expressed in equivalents per liter, and C_1 and C_2 are the concentrations of their anions in solution when equilibrium has been reached. The salts considered are well suited to study by this method, since the dissociation constants of the potassium salts are equal, and the silver salts are all totally dissociated; hence no corrections for inequalities in dissociation are necessary. By application of the foregoing formula to the four salts mentioned, in solutions of varying concentration, the relative solubilities at 25° C. are found to be as follows:

$$\begin{aligned} AgCl &= 1.00000 \\ AgCNS &= 0.07480 \\ AgBr &= 0.05500 \\ AgI &= 0.00077 \end{aligned}$$

The results are in close agreement with those that have been obtained by other methods.

The Hypothesis of Radiant Matter: MORRIS LOEB.

Dr. Morris Loeb reviewed the present status of the hypothesis of radiant matter. He showed that the Electron Hypothesis rests partly upon the Lorenz-Maxwell electromagnetic theory of light, especially as exemplified in the Zeeman effect, and partly upon the electro-conductivity of gases, as studied by J. J. Thomson and others. To this must be added the various phenomena of the electric discharge in vacuo as well as of the radiations from thorium, uranium and radium, which are likewise explained upon the assumption of small particles actually propelled from the electrodes or expelled from the atoms. This has led further to the idea of a corpuscular structure of the atom, for which corroboration is sought in the apparent decomposition of the elements, the "degradation" of those of higher into others of lower atomic mass. In the opinions of many, the constituent corpuscles are themselves not matter but electric disturbances of the ether. Dr. Loeb pointed out certain discrepancies between various parts of the theory, which must be explained away, before it could be accepted as a whole. Thus, measurements upon the Zeeman effect indicate a very small number of electrons; while Rutherford's transformation hypothesis calls for a very large number of freely moving particles within the atom. A nebular or corpuscular structure of the atoms would give the electrons of the cathode rays a so much greater free path, than would result from the existence of atoms as solid bodies, that it becomes difficult to account for the various phenomena attending increasing rarefaction in the Crookes tube upon the kinetic reasoning usually applied. The speaker also showed that most of Thomson's calculations upon the speed and masses of the electrons, which are usually cited as showing the non-existence of matter, really depend upon the arbitrary assumption that the numerator rather than the denominator of the ratio e/m is a constant; while he really transfers the chief attributes of matter to energy, without, as a matter of fact, reducing the number of our fundamental ideas. Discussing the recent experiments of Cameron and Ramsay, he argued that the appearance of sodium and lithium in a copper nitrate solution, exposed to the emanation from radium, could not be taken as proof for the decomposition of copper, until a corresponding loss of the latter metal shall have been demonstrated. It will be remembered that Cameron and Ramsay ascribe the transformation of the emanation into helium, the lightest of the inert gases, to the bombardment of α particles; when water is present to take up some of the energy, neon is produced; while copper salts still further shield the emanation atoms, so that they are only degraded to argon, the heaviest member of the series. In view of the great excess of water-molecules in the copper nitrate solution, Dr. Loeb holds that this hypothesis calls for the presence of a great deal of neon, mixed in with the argon, while Ramsay and Cameron emphasize its absence.

The Stereochemistry of Indigo: K. GEO. FALK and J. M. NELSON.

Experiments upon Barfoed's Acid Cupric Acetate Solution as a Means of Distinguishing Glucose from Maltose, Lactose and Sucrose: F. C. HINKEL and H. C. SHERMAN.

C. M. JOYCE,
Secretary

DISCUSSION AND CORRESPONDENCE

TWO NEW METEORITES

Ainsworth Meteorite.—This siderite, to which I propose to give the name of the town near which it was found, was recently purchased from Mr. J. C. Toliver. It was found last winter by one of Mr. W. G. Townsend's little boys, who called his father's attention to it, partly buried in the sand beside a small creek in Brown Co., Nebraska, about six miles northwest of Ainsworth. It measures approximately $4\frac{1}{2} \times 6 \times 7$ inches, and weighs $23\frac{1}{2}$ pounds (10.65 kilograms). The specific gravity of the whole mass is 7.85. A fractured surface—showing beautifully the coarse octohedral structure—on one of the sharper edges

and adjoining side, shows where a considerable piece, weighing perhaps two pounds, was broken off, antecedent to its burial, probably at the time it fell. Two of the projections on one side are flattened, as if by pounding, but closer examination shows fine striæ running evenly across both surfaces, which are in the same plain and partly join each other, suggesting that the meteorite in falling may have glanced on a rock, making a slickensided surface. The meteorite also shows two marks made by a sharp tool, like an ax, which also apparently antedate its last burial in the sand. But the most marked feature about this iron is the presence, on the surface, in a number of places, of bright unaltered triolites with a part of a crystal face showing in one place. This feature, in connection with the general freshness of the iron and the presence of what seems to be the original surface over a good part of it, indicates that it is a comparatively recent fall.

Williamstown Meteorite.—I secured this siderite last March from Mr. A. E. Ashcraft, who found it April 25, 1892, on his farm in Grant County, Ky., three miles north of Williamstown. It is a nearly square, thin, flat-shaped iron about $16 \times 12 \times 2\frac{1}{2}$ inches thick in the center, thinning to a blunt edge at either end. It was entire when it reached me, with the exception of a few ounces broken from one edge, and weighed 68 pounds (30.85 kilo.) and has a specific gravity of 8.1. It has already been cut into a number of sections, which etch very readily, showing the structure to be that of a Mediam octohedrite. Three distinct systems of Kamacite lands are cut at approximately right angles, while a third is cut at an angle of 60° or 70°, thus showing an apparent breadth of about three times that of the other lands. Triolite seems to be pretty generally distributed throughout the mass in very small grains, although two nodules about one half inch in diameter were revealed, but the total amount of this mineral is small, as might have been inferred from the general smoothness of the surface, and the specific gravity.

A fuller description of both of these meteorites will be given when the analysis, which will be made at the National Museum, is completed.

Edwin E. Howell

Washington, D. C.,
September 17, 1907

DR. ARMSBY'S NEW UNIT FOR ENERGY

In a paper read before the Society for the Promotion of Agricultural Science[1] Dr. Armsby suggests a new unit for energy. This unit is a million gram-calories and he calls it a *Therm*—spelled with a capital *T*. Since the word *therm* has been suggested and occasionally used to mean the gram-calorie, and since we are accustomed to use the prefixes *kilo* and *mega* to denote, respectively, a thousand and a million—as in kilometer, kilogram, kilowatt, megadyne, megohm—would it not conform better to our customary nomenclature to call the kilogram-calorie a *kilocalorie* and a thousand kilogram-calories a *megacalorie?* These names have the advantage that they would at once be understood by a man who had never seen them before, whereas the name *Therm* would for a time need explanation.

A. T. Jones

Purdue University

SPECIAL ARTICLES

SOME LIFE-HISTORY NOTES ON MEGARHINUS SEPTENTRIONALIS[2] D. AND K.

Some observations upon the life history of this rather rare and beautiful species of mosquito were made at this station[3] during the past season.

On September 10, 1906, the senior author collected 24 larvæ of this species and several of a smaller species, probably *Culex pipiens*, from a half-barrel tub of rain water, not more than 100 feet from an inhabited dwelling, on a farm near Church Hill, Tenn. All were placed in a small pail together and carried overland twenty-three miles in a buggy and then forty on the train to this laboratory,

[1] Science, Vol. XXVI., p. 670.

[2] Smithsonian Miscellaneous Collections, Vol. 48, Part 3, No. 1657.

[3] Tennessee Agricultural Experiment Station, Knoxville.

where they arrived September 14. When examined the next morning but two of the larvæ and one pupa of the smaller species remained, the others having been devoured by their larger predatory companions.

The *Megarhinus* larvæ, which had just passed through the last molt (September 10–11, 1906), were placed in beakers containing tap-water, allowing several individuals to each beaker, and kept in the laboratory. They were fed on the larvæ of smaller species, chiefly *Stegomyia fasciata* and *Culex* sp., until October 10, after which time we were unable to secure a further supply of these out of doors.

When feeding upon the smaller larvæ the *Megarhinus* larvæ swallow their prey bodily, but when practising cannibalism, as was observed in two cases, the victim is held in the strong mandibles and slowly devoured. So far as observed these larvæ make no apparent effort to pursue their prey, but remain quietly near the bottom of the water until a smaller larva approaches, when with a quick movement the latter is seized in the powerful mandibles and speedily disappears. In the several instances observed no effort was made to change the hold, whether the prey was first seized near the head, middle or tail. One larva was seen to seize a nearly mature larva of *Culex salinarius* near the middle, and without loosening its hold to swallow it gradually, the head and tail disappearing together. Considerable difficulty attends an attempt at swallowing their prey head foremost, as one instance was noted where the usual three or four minutes were stretched to more than an hour before the still struggling victim finally disappeared. The *Megarhinus* larvæ are able to remain entirely submerged for hours at a time, even during comparatively warm weather, which fact probably accounts for their habit of wintering in the larval stage.

Four of the larvæ died before December 10, 1906, and on that date six of the remaining twenty were transferred to an earthen jar containing about three inches of mud, above which was two inches of water. This jar was sunk into the ground almost up to the rim in a wire screen house out of doors and sheltered from the direct rays of the sun. Here these six larvæ remained throughout the winter. The lowest temperature to which they were subjected was $+13°$ F., on the morning of December 24, 1906. This cold snap continued two days, freezing ice three fourths of an inch in thickness on the water in the jar. On the afternoon of December 26 the ice had thawed around the edges sufficiently to allow it to be lifted out of the jar, when one larva was found with its anal breathing tube frozen fast in the ice. The other larvæ were lying on the surface of the mud in a semi-torpid condition. One of the larvæ died as a result of this freeze, and by March 12 two others were dead. On March 25 one of the remaining outside larvæ pupated, and another on the thirtieth. A drop in temperature to $+30°$ F. on the morning of April 2 caused the death of the remaining outside larva and one pupa. The other pupa was so weakened by a freeze on April 15, when the mercury fell to $+26°$ F., that it died two days later.

On December 15 five of the fourteen larvæ kept in the laboratory were transferred to a beaker, in the bottom of which was about two inches of mud, thus duplicating the conditions of the lot kept outside, except as to temperature. No difference in behavior could be noted, except that the larvæ were more active, as would naturally be expected from the higher and more uniform temperature of the steam-heated room.

Of this lot two larvæ transformed to the pupa state, in which condition one died, the other emerging as adult (female) on April 4. The last larva died April 18.

Soon after the mud was placed in the beaker a number of cyclops and other small water animals were observed swimming about. These were still present this spring, although the mosquito larvæ were without food for a period of five months, during which time they continued active, but were never seen to make any attempt to feed upon these smaller forms of water life. Nor did they during this time resort to cannibalism; but when several larvæ of *Culex salinarius* were placed in the beaker on March 12 they were devoured with great

avidity. This interesting observation indicates a narrow food habit for this species.

Of the nine remaining larvæ of the original lot, five were reared to the adult state. The first pupa appeared March 8, the adult emerging five days later. Thus 179 days had elapsed between the date of collection and the date of pupation, during the last 149 of which the larvæ had been without food.

Among the larvæ kept out of doors, which were under nearly natural conditions, the first pupa appeared 196 days after the date of collection and the last 201 days. The latter lived 18 days, but the adult failed to emerge.

This would indicate that under natural conditions one would expect the pupæ to appear during the latter part of March and most of April and the adults during April and possibly May.

The average length of the known larval life of the ten individuals which transformed to the pupa state was 196.5 days. The shortest period was 179 days, and the longest 205 days. How much it would be necessary to add to this in order to arrive at the total larval life is not known; nor do we know the incubation period, as we were unable to secure eggs.

The shortest pupal period was five days, the longest 11 days, and the average 7.3 days. The shortest adult life was one day, the longest 11 days, and the average 6.8 days. It is probable that with natural conditions the adult stage would have been somewhat lengthened, for this species is rather shy and could not be expected to thrive well under close confinement.

From the fact that a few adults were present when the larvæ were collected, September 10, 1906, together with the dates of emergence of those we reared, we are led to believe that there are at least two broods per year at this latitude. These broods probably are not sharply defined, because of the variation in time required to hatch the eggs of those mosquitoes which lay their eggs singly. It is probable that during the latter part of summer all stages may be found together.

H. A. Morgan
E. C. Cotton

DISSOROPHUS—A CORRECTION

In the *American Naturalist* for November, 1895, Professor E. D. Cope described (p. 998) a new form of Paleozoic amphibian, from the Permian of Texas, which he designated by the name of *Dissorophus multicinctus*. He based the new form on a series of "ten consecutive vertebræ and their appendages" and on account of the peculiar carapace referred to it as a "batrachian armadillo." He characterized the new form as follows:

> The neural spines are elevated, and the apex of each sends a transverse branch which extends in an arch on each side to the ribs. These spinous branches touch each other, forming a carapace. Above and corresponding to each of them is a similar dermal osseous element, which extends from side to side without interruption on the median line, forming a dermal layer of transverse bands which correspond to the skeletal carapace beneath it.

In the *Proceedings of the American Philosophical Society* for May 15, 1896, Cope published on Plate X. three figures of the same specimen and gave the name as *D. articulatus* Cope. Again in the *American Naturalist* for November, 1896, under the title of "Permian Land Vertebrates with Carapaces" (p. 936), he gave additional notes on *Dissorophus* and repeats the same figures which were given in the *Proceedings of the American Philosophical Society*, 1896, Plate X., and again gives the name as *Dissorophus articulatus* Cope.

In Hay's "Catalogue of the Fossil Vertebrata of North America," there are given two species of *Dissorophus*, *D. multicinctus* Cope, and *D. articulatus* Cope, and reference to the *Proceedings of the American Philosophical Society*, 1896, Plate X., is omitted. Broili ("Paleontographica," 1904) follows Hay, evidently, in making out his list of the Stegocephalia of the Permian of Texas, since he also gives the two species of *Dissorophus*.

There can be no doubt that there is but one species of *Dissorophus* and that species is *Dissorophus multicinctus* Cope first described in 1895. That the specimen first described is the same as the one figured on Plate X. of the *Proceedings of the American Philosophical Society*, can not be questioned. Cope

says the specimen consisted of "ten consecutive vertebræ and their appendages," and this is the number of vertebræ figured on the plate. Nowhere is *D. articulatus* designated as a new species and the original description applies exactly to the figures there given.

Cope's ability to shift names is well known to those who are accustomed to deal with subjects treated by him, but usually such shifted names were detected, either by Cope or others. This appears not to be the case with *Dissorophus* and, so far as I can learn, the correction has never been made. *Dissorophus multicinctus* Cope is the only species of that genus which is valid and it is desirable that the synonymy of *D. articulatus* with the first described *D. multicinctus* should be established before the mistake goes further into the literature.

ROY L. MOODIE
THE UNIVERSITY OF CHICAGO,
November 14, 1907

CURRENT NOTES ON LAND FORMS

THE PENEPLAIN OF NORTH CENTRAL WISCONSIN

THE peneplain of north central Wisconsin has been recently described with rare skill by S. Weidman in a state survey report (Chap. XII., pp. 575–631, in "Geology of North Central Wisconsin," Bull. XVI., Wisc. Geol. and N. H. Surv., 1907). The teachers of the state and geographers in general will here find excellent account and illustration of the still undissected parts of the peneplain, of the well-defined, though small, monadnocks that rise above it, and of the valleys that have been eroded beneath it; they will find also a well-considered and lucid discussion of the origin of these features. The once continuous upland is ascribed with good reason to the destruction of ancient mountains of disordered and generally resistant rocks in an almost complete pre-Cambrian cycle of subaerial erosion. The submergence of the resulting peneplain, its burial beneath an unconformable cover of paleozoic strata, the elevation of the region with the resultant removal of the covering strata and resurrection of the buried peneplain, and the dissection of the peneplain by superposed rivers are all clearly set forth. The upland rises from 1,000 feet at its southern border to 1,500 feet at the northern part of the area. As the rivers are followed southward, there is a gradual transition from well-enclosed valleys, 200 or 300 feet deep, floored and sided with disordered rocks, through shallower valleys, floored with disordered rocks but sided with stratified rocks, to open valleys, floored and sided with stratified rocks. There is a corresponding passage from higher, more northern uplands of disordered rocks, through somewhat lower uplands, patched over with scattered remnants of the once more extensive cover of stratified rocks, to the lower ground of the still remaining, continuous stratified cover. All these features are so well presented that they may be accepted as standard accounts of typical physiographic features. If a hesitating geographer is still to be found, unconvinced of the desirability of replacing older empirical methods by newer explanatory methods in the description of land forms, let him read this essay.

The attention of others engaged upon physiographic reports for state surveys may well be directed not only to the general plan of this report, but particularly to four helpful block diagrams (pl. 68–71), which promptly and concisely set forth the essentials of the story to be told, so that its details may afterwards be apprehended in proper relation to the more general features. The chapters on glacial and alluvial deposits also contain geographical material. One of the very few points on which Weidman's form of statement might be changed to advantage is that concerning the adjustment of rivers. It is said: "Under normal conditions, streams . . . tend, not only to flow in nearly direct courses, but also to avoid the harder rocks, thus seeking to establish their courses upon the softer formations and to move along lines of least resistance" (p. 616). This might give the impression that the establishment of stream courses along belts of weak rocks is accomplished by the preexistent streams themselves, as an active, almost intentional process. The quoted phrase might be changed to read: "Streams of early origin are often led to avoid the harder rocks by the later development of subsequent

streams along belts of weaker rocks." It is not clear why the technical term, baselevel, should be printed as two words in a report which makes a single word of waterfall.

W. M. D.

DEFLECTION OF RIVERS BY THE EARTH'S ROTATION

The sufficiency of the earth's rotation to deflect rivers has now been debated many years. The deflective force is well understood to be independent of azimuth and to increase with the sine of the latitude, but to be so weak as to be of questionable value in spite of its persistence. Nevertheless, the observations of von Baer and others regarding Russian rivers, the well-marked asymmetry of the radial valleys on the great fan of Lannemezan in southwestern France, and the occasional instances of unsymmetrical valleys reported in different parts of this country by Kerr, Gilbert and others, have kept the matter in the mind of geographers. As to the Russian rivers, particularly the Volga, where a long-maintained right-handed tendency has resulted in a strong inequality of valley-side slopes, no efficient explanation in place of the deflective force of the earth's rotation has been offered. As to the radial valleys of the Lannemezan fan, L. A. Fabre has given good reasons for regarding their steeper right and less steep left sides as dependent on the westerly source from which their rains usually come; and as to the greatest of our own rivers, for which the detailed maps of the Mississippi river commission give unusually accurate quantitative measures of lateral erosion, the studies of I. Bowman, published in Science a few years ago, leave little doubt that the rotation of the earth, which would turn this south-flowing river westward, has less control than the prevailing winds, which brush it eastward.

A presumed effect of deflection upon river courses has been pointed out by certain Austrian geographers, who have noted that some of their larger rivers, especially the Danube, turn to the left in long curves, convex to the right, while passing across alluvial plains between notches in rock ridges; the left-handed turning of the river curves being the necessary result of the right-handed pressure of the river between its pairs of (relatively) fixed points. Had the original course of these rivers been direct, from notch to notch, the deflective force of the earth's rotation, even though quantitatively weak, would have been at least qualitatively appropriate to bring about the existing curved courses.

DEFLECTED RIVERS IN AUSTRALIA

Few examples of deflected rivers have been noted in the southern hemisphere; hence an especial interest attaches to some instances reported by T. G. Taylor in Australia ("A correlation of contour, climate and coal; a contribution to the physiography of New South Wales," *Proc. Linn. Soc. N. S. W.*, XXXI., 1906, 517–529). It is pointed out that several members of the Murray river system, on the inner plains west of the mountains back of Sydney, exhibit a persistent tendency to turn to the left, while sweeping around long curves convex to the right. It is urged that as the rivers flow for several hundred miles across a nearly level district where there are no rock outcrops to determine their courses, the earth's rotation should become a prime factor in guiding them.

It is with regret that we have to conclude that the explanation offered by Taylor for these left-curving rivers is not valid. There is no indication that the rivers are held in rock notches at the ends of their curves, and it is, moreover, evident that if the reason given for the Danube curves were applied to the Australian rivers, they ought to turn to the right in long curves convex to the left. The case would then be somewhat analogous to that of cyclonic winds, which being deflected from the barometric gradients by a right-handed force in the northern hemisphere, there curve to the left in spiral inflows to low pressure centers; or by a left-handed force in the southern hemisphere, there curve to the right. It is implied by Taylor that the Murray river branches were originally straight, presumably on lines now indicated by the tangential prolongation of their upper waters; hence the greatest amount of deflection should have been in the lower course of each curved branch; but

this does not appear to be a legitimate consequence of the earth's rotation. Moreover, Taylor goes on to say that the two rivers least deflected are the Murrumbidgee and the Murray, "which is what one would expect, since their course is practically at right angles to the meridians." But the deflective force being independent of azimuth, and these two rivers being farther from the equator than any other members of the Murray system, they are precisely the two that should show the greatest deflection. Finally, no adequate consideration is given to other possible controls of the river courses in question; yet in view of the fact that the left-hand curving of the rivers leads them toward the lower part of the trunk river, it may well be that their courses are essentially consequent upon the various processes that have in a general way given shape to the Murray basin. It does not, therefore, seem warranted to regard these Australian rivers as having been deflected by the earth's rotation.

W. M. D.

THE WORK OF OUR LARGER MUSEUMS AS SHOWN BY THEIR ANNUAL REPORTS

A NUMBER of museum reports, including those of our largest institutions, have appeared during the past summer, all somewhat belated, though any one acquainted with the work of museums can understand and excuse much of this delay. They comprise the reports of the United States National Museum, American Museum of Natural History, Field Museum of Natural History, Carnegie Museum, Museum of the Brooklyn Institute and the Public Museum of Milwaukee. These are the largest of our museums and it may be well to note what they are doing for the public.

The cramped and crowded condition of the present building of the United States National Museum precludes many changes in or additions to material on exhibition, but the accessions to the collections have been many and valuable. The most important among them were the collection of arms, numbering 569 pieces, deposited by the United States Cartridge Company, and the Schaus collection of Lepidoptera, comprising about 75,000 specimens. That research work has not flagged is shown by the list of papers published in the *Proceedings,* and the liberal policy of allowing others than members of the museum staff to study material or publish the results of their observations. The list includes many names and covers a great range of subjects.

As a forecast of future arrangements in connection with the new museum building, it is noted that this will contain the collections of archeology, ethnology, natural history and geology; that a portion of the Smithsonian building will be given over to art and that the present building will contain the technical collections.

As to art, the gifts of the Freer and Evans collections provide the opportunity for removing the stigma that the United States is the only large nation without a national gallery of art.

The report of the American Museum of Natural History is, as usual, somewhat brief and formal, though presenting a concise view of the year's work.

It seems to be taken for granted that museum reports will only be read by those directly concerned, and, acting on this assumption, little is done to make them interesting, though the illustrations probably appeal to the average man rather than the text.

Two prominent features of the year are the acquisition of a considerable number of skeletons of whales, the commencement of a life-sized reproduction of a sulphurbottom whale and the installation of a number of new and beautiful bird groups. Hitherto cetaceans have been but poorly represented in this museum and it is the evident intention to remedy this defect. The bird groups are an attempt to show certain phases of the bird life of North America in a more realistic and more beautiful manner than has hitherto been done. The methods employed are an adaptation and amplification of those in use, or suggested, and the results far in advance of those previously attained. Groups of animals may be treated from various standpoints, the one most commonly taken being that introduced by the British Museum, in which birds or other ani-

mals are shown as nearly as possible with their exact surroundings. This often results in subordinating the animal to its accessories. Another plan is to either select such animals as are particularly interesting in themselves, or more or less remarkable in habits, or, when commoner animals are shown, to make the surroundings more or less subordinate, to suggest nature rather than imitate it. In the one case the result is a beautiful picture in which the animals are a small part. In the other emphasis is laid on the animal itself. Both methods have their uses and the museum that can will do well to employ both in its exhibition series.

It is sad to note that the first report of the Field Museum of Natural History should be the one to record the death of its founder, Marshall Field, whose portrait forms the frontispiece of the volume. By his liberality this museum came into existence full-fledged and started with greater collections than have fallen to the lot of any other new museum.

The plans for the new museum building, which had been in preparation for some time, called for the expenditure of more than the four millions left by Mr. Field for that purpose, and the plans have accordingly been revised. As soon as the legal obstacles that have for some time stood in the way have been removed, the work of construction will be commenced. This museum is well to the fore in anthropology and is making rapid strides in botany and the principal accessions of the year have been in these departments. In spite of the probable removal of the museum, the work of installation has proceeded steadily.

A part of the report of the Carnegie Museum is couched in apologetic language, and expresses the dissatisfaction of the director at seeing the doors thrown open to the public before the museum was in proper condition to receive them. As the director says:

> What has been accomplished only represents the partial fulfilment of his ideals, and it undoubtedly will be several years before the museum will begin to assume proper shape and the various collections which it is destined to contain will have been brought into thoroughly systematic order.

But we fear if museum directors waited until they were prepared for the public, the doors of the museums would never be opened, and in answer to Dr. Holland we quote as follows from the report of the Brooklyn Institute Museum:

> The outlook at times too may seem most discouraging, there are so many things planned and so few completed. Work of all kinds remains unfinished, important specimens are needed in all departments, labels are lacking, cases disarranged and many things conspire to render the lot of an energetic curator an unhappy one. Moreover, a museum is generally the resultant of many forces and consequently a compromise of what the director would like to have it and what he is compelled to do.

Finally, no apologies are necessary from Dr. Holland, but congratulations for what has been accomplished. For in spite of the obstacles which may have interfered with its activities, but have not stopped its growth, work has steadily gone on, especially in the section of paleontology, which has become so important and striking a feature of this institution; and valuable material has been collected from the Fort Benton Cretaceous, and the mounting of the great Diplodocus skeleton completed. This institution also ranks high in the number and character of its publications, the most important for the year being a memoir on the crayfishes of Pennsylvania, which is a good example of work that may be done near home.

The Museum of the Brooklyn Institute is the most recent of any under consideration, having been opened in June, 1897. It differs from the others in being a museum of art as well as of science, thus differing from most other institutions in the United States, for while the Carnegie Institute includes museums of art and science, these have each their own director, their common bond being through the board of trustees. It differs also in distinctly providing for children and teachers by its Children's Museum, whose exhibits and lectures are directly planned to interest the one and aid the other. Various institutions,

notably the American Museum and the Carnegie Museum, provide lecture courses for teachers and children, the initiative having been taken by Professor Bickmore more than twenty-five years ago. The Carnegie Museum, American and Milwaukee Museums also issue loan collections, the commencement having been made by the Milwaukee Museum.

The chief accessions of the year in the line of natural history were the Ward collections of sponges and corals, the first numbering over 800 species, the latter over 200. They provide for an unusually full exhibit in these branches of zoology, as the specimens were originally brought together with a view to exhibition and not for study. Work was continued among the Indians of the southwest, in order to round out the important collections of that region, but especial attention was directed to the Pomo tribe of California. The approaching completion of the new wing of this museum will finish the north front and provide for future growth.

Perhaps the most important deduction to be drawn from a perusal of these reports is that a great amount of attention is being paid to the educational side of museum work and large expenditures of thought and money are made to render them not simply instructive, but attractive to the public. And there are many weighty reasons for believing this to be the correct view of the duty of the museum.

These institutions are largely supported by public funds and the public has a right to expect a due return for its investment. Dr. Boas may be, undoubtedly is, wrong in some of his views regarding the principles of museum administration, but he is entirely correct in his assumption that the majority of visitors to a museum do not seek anything beyond entertainment. If he errs at all, it is in placing the proportion of such visitors too low. Therefore, in the exhibition of specimens, the aim should be not merely to furnish information to the man who is looking for it, though this should assuredly be done, but to attract and interest the chance or indifferent visitor and to arouse in him a desire for further knowledge.

The particular attention given to the collection, study, and display of fossil vertebrates is a direct outcome of the extensive deposits of fossils in the western states. These afforded an opportunity that was embraced by American men of science and the art of collecting and mounting this class of material has reached a higher point here than in any other country, skeletons of gigantic dinosaurs and tiny mammals being mounted as if they were the skeletons of modern animals. Thus the life of the past, once considered as a mysterious branch of research, has been brought within the grasp of the average museum visitor.

The American Museum has in this line of work literally carried the war into Africa and despatched an expedition to the Fayum in search of examples of the primitive elephants and other interesting animals discovered by Beadnell and Andrews.

We are accustomed to regard the number of visitors to a museum as a measure of its importance and public usefulness, but it may more properly be looked upon as an indication of its interest for the public and to some extent of the state of the weather. If it is of interest to the public, there is small doubt but what it will prove to be useful.

The Milwaukee Museum is so arranged that the attendance can not well be taken; the Carnegie Museum has been closed for the past year; attendance at the others was as follows:

U. S. National Museum and Smithsonian Institution	360,547
American Museum of Natural History	476,133
Field Museum of Natural History	254,516
Brooklyn Institute Museum, including Children's Museum	229,028
A total of	1,320,224

The visitors at the U. S. National Museum are largely from out cf town, but the great majority of those at other institutions are residents, and it speaks well to those who know how inconvenient of access is the Field Museum that a quarter of a million of people should have found their way to it. When this museum is transferred to the Lake front, the attendance will be vastly increased just as the number of visitors at the American Museum nearly doubled the year after the establish-

ment of the elevated station at 82d Street. This museum now enjoys the best location of any in the country, so far as ease of access is concerned and not unnaturally stands first in the number of its visitors.

Museum attendance, as shown by the report of the U. S. National Museum, is subject to great fluctuation and, like sun-spots, has its maximum and minimum periods. After each inaugural year there is a drop to below the normal and in the years 1905 and 1906 attendance was less than in any previous year. There is a curious correlation between the loss here and the great falling off in attendance at the British Museum, where the Bloomsbury Square institution reports a loss of 122,000 and the Museum of Natural History of 95,000 visitors. It can not be said that this is due to any fault or deterioration of the exhibits or administration of these or other museums.

The American and Field Museums both offer extended series of lectures on topics akin to the work of the museums and these are fairly well attended. The Field Museum has arranged to have its lectures during the coming year given in the Hall of the Art Institute, in which it will not be handicapped by its location.

After all, the amount of real good effected by lectures is somewhat of a problem. Formerly lectures were given because the speaker had something to impart, but not unnaturally the pictures have come to be regarded as more important than the words, or at least more desired by the public. This is not wholly to be wondered at or deplored, for pictures often give a clearer idea of facts and things than descriptions, illustrations being the equivalent of the objects on exhibition in a museum.

It is very evident from the lists of material received and papers published that the scientific side of museum work is not receiving any less attention than heretofore, simply the public is very properly getting more.

F. A. Lucas

THE GENERAL MEETING OF THE AMERICAN PHILOSOPHICAL SOCIETY

A committee of the general society has been formed to arrange for a meeting to be held on April 23, 24 and 25, 1908. The committee consists of George F. Barker, Philadelphia; John A. Brashear, Pittsburg; William Keith Brooks, Baltimore; Ernest W. Brown, New Haven; Thomas C. Chamberlin, Chicago; Charles F. Chandler, New York; Edwin Grant Conklin, Philadelphia; Henry H. Donaldson, Philadelphia; Charles L. Doolittle, Upper Darby, Pa.; Arthur W. Goodspeed, Philadelphia; I. Minis Hays, Philadelphia; Morris Jastrow, Jr., Philadelphia; David Starr Jordan, Stanford University, Cal.; Charles R. Lanman, Cambridge; Marion D. Learned, Philadelphia; Simon Newcomb, Washington; Edward L. Nichols, Ithaca; Henry F. Osborn, New York; Edward C. Pickering, Cambridge; Henry A. Pilsbry, Philadelphia; Ira Remsen, Baltimore; William B. Scott, Princeton; Thomas Day Seymour, New Haven; Edgar F. Smith, Philadelphia; Edward B. Titchener, Ithaca; William Trelease, St. Louis, Charles D. Walcott, Washington; Woodrow Wilson, Princeton; William H. Welch, Baltimore; Robert S. Woodward, Washington.

This committee has sent out the following letter:

The American Philosophical Society has satisfactorily shown that the interests of useful knowledge in the United States may be greatly promoted by the annual general meetings of the society. Such meetings have proved attractive to its members in all parts of the country, not only because of the general interest in the scientific communications offered, but also because of the opportunities afforded of renewing and extending acquaintanceship among workers in the various fields of knowledge, and they have markedly broadened the field of usefulness of this, the oldest scientific society in America.

The general meeting of 1908 will be held on April 23 to 25, beginning at 2 P.M. on Thursday, April 23, and the above committee has been appointed to make the necessary arrangements.

Members desiring to present papers, either for themselves or others, are requested to send to the secretaries, at as early a date as practicable, and not later than March 25, 1908, the titles of these papers, so that they may be announced on the program which will be issued immediately thereafter, and which will give in detail the arrangements for the meeting.

Papers in any department of science come within the scope of the society, which, as its name indi-

cates, embraces the whole field of useful knowledge.

The publication committee, under the rules of the society, will arrange for the immediate publication of the papers presented.

The activity of the society is reflected in the increasing volume of its publications, which constitute a series covering one hundred and forty years, and include *Transactions* in quarto and *Proceedings* in octavo; its exchange list embraces most of the scientific societies of the world. The society thus offers valuable avenues of prompt publication and wide circulation of the papers read before it.

SCIENTIFIC NOTES AND NEWS

THE colleagues and friends of Professor A. A. Michelson and those who appreciate the honor done to this country by the conferring on him of the Copley medal of the Royal Society and the Nobel prize in physics, have arranged to unite in a dinner at Chicago on January 3, the last day of the meeting of the American Association for the Advancement of Science.

THE Munich Academy of Sciences has elected as corresponding members Mr. G. K. Gilbert, of the U. S. Geological Survey, and Professor J. J. Thomson, professor of experimental physics at Cambridge University.

THE Hayden memorial geological medal of the Academy of Natural Sciences of Philadelphia will be presented to Mr. Charles D. Walcott, secretary of the Smithsonian Institution on Tuesday evening, January 7. The presentation address will be made by Dr. Persifor Frazer.

SIR W. H. BENNETT has been elected president of the Institute of Hygiene, London, in succession to the late Sir W. H. Broadbent.

DR. BERTHOLD LAUFER, lecturer in anthropology in Columbia University, has accepted the position of curator in the Field Museum of Natural History in Chicago and will proceed on January 7 to Thibet, where he will spend three years. The money for the expedition has been given anonymously.

PROFESSOR DUGALD C. JACKSON, of the Massachusetts Institute of Technology, Boston, has consented to act as temporary technical assistant of the expert accountant engaged in devising a system of bookkeeping by which the city can keep informed of the financial operations of the Chicago Telephone Company under the new ordinance.

DR. GEO. I. ADAMS, has returned to Washington from Peru, where since 1905 he has been chief geologist to the government of Peru.

A SMITHSONIAN grant has just been approved by Secretary Walcott in favor of Professor William Hallock, of Columbia University, New York, to investigate a 3,300-foot well near Oakland, Maryland. Among other things, Dr. Hallock will determine, if possible, the conductivity of gas at this extreme depth and will try to get information as to the possible radioactivity of rock far below the surface.

PROFESSOR HENRY B. WARD, of the University of Nebraska, has been elected a foreign member of the Russian Imperial Society for the Acclimatization of Animals and Plants.

THE Société d'Anthropologie de Paris has elected Dr. Ales Hrdlička an associate foreign member. Heretofore he had been a corresponding member.

DR. STROUD proposes to resign the Cavendish professorship of physics in Leeds University, after twenty-two years' service.

DR. HERMANN GRAF ZU SOLMS LAUBACH, professor of botany at the University of Strasburg, has retired from active service.

DR. GUSTAV JÄGER, of Stuttgart, known for his contributions to hygiene, has celebrated the fiftieth anniversary of his doctorate.

IT is stated in *Nature* that Mr. Haffkine has accepted an appointment to a post at Calcutta offered to him by the secretary of state for India. It will be remembered that Mr. Haffkine was held responsible for an unfortunate accident that occurred in the Punjab in connection with plague inoculation, an accident for which a large body of scientific opinion has pronounced him to be in no way to blame.

WE learn from the *Geographical Record* that Mr. Leo Frobenius, the German ethnologist and explorer, whose researches along the

Kasai River in 1904–6 are well known, has returned to inner Africa, to make further investigations. He is accompanied by Dr. Hugershoff as surveyor and geologist and Mr. Fritz Nansen as cartographer and photographer. The party will study, for a year, the little-known region to the south of the great Niger bend. Another year will be spent along the lower Niger, and, if the health and resources of the expedition permit, similar investigations may be extended to Togo and the Cameroons.

Dr. Ernest H. Starling, professor of physiology in the University of London, will give the Herter lectures of the year on the subject "The Fluids of the Body," beginning on January 6 at 4 P.M. and continuing at the same hour throughout the week at the Carnegie Laboratory of the University and Bellevue Hospital Medical College, 338 East 26th Street, New York City.

Dr. Frank Thilly (A.B. Cincinnati, '87), Sage professor of philosophy at Cornell University, made the address on the occasion of the first reunion of the colleges of the University of Cincinnati. The subject of his address was "University Ideals."

At a meeting of the Geographical Society at Philadelphia on December 19, Captain Roald Amundsen gave an illustrated account of his discovery of the Northwest passage.

It is reported that the remains of the philosopher Kant are to be transferred to the Fürstengruft of the cathedral in Königsberg.

We regret to record the death on December 29 of Dr. Coleman Sellers, at the age of fifty-nine years. Dr. Sellers was chief engineer of the Niagara Falls Power Company and chief mechanical engineer of the Canadian Niagara Power Company. He had been president of the American Society of Mechanical Engineers and of the Franklin Institute of Philadelphia.

The death is announced of Mr. M. Walton Brown, secretary of the British Institution of Mining Engineers.

The Rev. George Nelson Webber, D.D., who had been professor of philosophy at Middlebury College and Smith College, died on December 20, at the age of eighty-one years.

Professor Oskar Lassar, of the University of Berlin, known for his work in dermatology, died on December 23, at the age of fifty-eight years.

There will be a civil service examination on January 15 and 16 to fill four vacancies in the position of aid in the U. S. Coast and Geodetic Survey with a salary of $750 per annum. An examination is also announced for the position of chemist aid in the Bureau of Chemistry, department of agriculture, at a salary of $1,000. Applicants will not be assembled for this examination, but will be graded on their education and training. On January 29–30, 1908, there will be an examination to fill at least three vacancies in the position of miscellaneous computer, Naval Observatory, Washington, D. C., and vacancies requiring similar qualifications as they may occur in that observatory. The department states that miscellaneous computers are paid by the hour and earn from $1,000 to $1,200 per annum. Promotions are made from this grade, without further examination, to the grade of assistant, at $1,200 per annum, as vacancies occur.

At the meeting of the Department of Superintendence of the National Education Association in Washington, D. C., February 25–26–27, considerable attention will be given to agricultural education. A round table conference will be held at which will be discussed among other things "Cooperation between the State Agricultural College and the State Normal School in Training Teachers for Elementary Agriculture" and "Cooperation between the United States Department of Agriculture and State School Authorities in Promoting Agriculture in the Public Schools." Arrangements have also been completed to organize at the February meeting a "Department of Rural and Agricultural Education" coordinate with other departments of the National Education Association. Permission to organize this department was given by the board of directors of the National Educational Association at the meeting in Los Angeles in July, 1907.

At the meeting of the Cardiff City Observatory committee on November 30, says *Nature*, it was announced that arrangements are busily proceeding for the installation of a seismograph at the observatory on Penylan Hill. The seismograph is being provided by the Cardiff Naturalists' Society, its up-keep being undertaken by the city council. It is hoped that the instrument may be installed early in the new year, and that Professor Milne will be able to attend the opening. Professor Milne has urged the establishment of a seismograph at Cardiff, which will form a triangle with the existing stations at Birmingham and Shide.

It is stated in *Symon's Meteorological Magazine* that the commonwealth of Australia has inaugurated a meteorological bureau for the whole continent, with its headquarters in Melbourne, and Mr. H. A. Hunt has been appointed the first commonwealth meteorologist. The new bureau will have control of the weather service over an area scarcely less than that of the United States or the Dominion of Canada, and very much larger than that of India.

A number of government bureaus and scientific societies of Germany have united to establish a series of meteorological stations extending through western Anatolia and Mesopotamia, situated at Marash, Urfa, Mesereh, near Kharkut; Kalat Shergat and Babylon. It is expected that these stations will supply information concerning the meteorological conditions of the high plateau and mountain land of the Taurus system and of the plateau and steppes as well as the alluvial region of the Euphrates and Tigris.

Captain Benard, the commander of the *Jacques Cartier*, a vessel now being equipped for a Polar expedition which is expected to leave France at the end of March, has given some particulars of the enterprise to the press. It appears that the expedition has been organized by a group of French students of oceanography, the object being the observation of facts belonging to that branch of science, as well as maritime meteorology, the discovery of new fishing grounds, and the exploration of territory believed to contain valuable mineral deposits. There is no intention to break the Polar record, but merely to explore an almost unknown region, opening up a new field of action to the owners of fishing fleets and to the French mining industry. Scientific observations will be made in the bays of Novaya, Zemlya, the Matotchkin Shar, and the Kara Sea, which will benefit not only France but all Europe.

The Royal Meteorological Society, in order to encourage the teaching of facts regarding weather and climate in schools, are inviting elementary teachers and others to send in essays in the form of an original nature-study lesson on weather or climate (not exceeding 1,500 words in length), together with a brief synopsis of five other lessons to cover the whole subject of climate and weather. If essays of sufficient merit are received, three prizes will be awarded of £5, £3 and £2, respectively.

We take the two following notes from the *Journal of the American Medical Association*: "The Vienna papers announce that forty-five grains of radium have been extracted from ten tons of ore given the Vienna Academy of Sciences by the government. The Austrian government refuses to sell the ore to foreigners." "The German railroads have ordered that the vision of employees must be tested henceforth with the colored plates originated by Professor W. Nagel, of Berlin, in place of the Holmgren skeins and yarns, hitherto used for the tests."

According to the London *Times* the British Weights and Measures Association has presented to the Chinese Minister in London a petition signed by 100 British firms doing business in China. By an imperial edict issued in Peking on October 9 the Board of Revenue and Commerce was ordered to introduce a uniform system of weights and measures throughout the Chinese empire and to fix the standards within six months. The petition asks that the standards to be adopted as the base of the new uniform system should be uniform with or multiples and sub-multiples without fractions of, the English standards,

on the ground, among others, that the trading relations between the Chinese and the British empires are now based on these standards, which are, the petitioners contend, those in most general use in the commerce of the world.

We learn from the London *Times* that the general purposes committee of the Birmingham Chamber of Commerce, having instituted an inquiry relative to the proposed compulsory adoption of the metric system, reports that opinion is divided on the question. The strongest opposition to compulsory adoption so far as the Birmingham and Midland district is concerned is to be found in the engineering trades. "It is stated," the committee reports, "that practically all engineering standards are based upon the inch, and it follows that all British-made ships, rolling stock, machinery gauges and tools, etc., are constructed according to these standards, the equivalents of which it is impossible to specify accurately in metrical measure. English-made machinery now in use in every part of the world made to our standard gauges on the interchangeable principle can have spare parts sent out of stock, but if any other standard is set up it would be necessary for the user of such machinery when ordering spare parts to specify whether the machinery was made before the passing of the proposed act, and would cause endless confusion and annoyance with customers at home and abroad." Whilst recognizing that the metric system is now much more widely used by traders in foreign transactions than was the case a few years ago, the committee seriously urge every trader interested in foreign trade to make use of the metric system wherever it may appear to be to his interest to do so. They are convinced that the commercial interests of the country will be much better served by gradual and voluntary adaptation than by legislation of a compulsory character.

UNIVERSITY AND EDUCATIONAL NEWS

Trinity College, Cambridge University, benefits to the extent of $2,000,000 by the death of Lady Pearce. Her husband, Sir William George Pearce, chairman of the Fairfield Shipbuilding and Engineering Company, died on November 2 last. By his will his fortune was bequeathed to Trinity College on the death of Lady Pearce.

Lord Newlands has given £20,000 to Glasgow University for the establishment of scholarships to be held by students going from Glasgow University to Balliol College, Oxford.

M. Théodore Vautier has given 100,000 francs to the University of Lyons for research work in experimental physics.

Mr. W. F. King, boundary commissioner of Canada, has given to the geological laboratories of the Massachusetts Institute of Technology a valuable collection of rocks. The institution has further received from the estate of Caroline Whitney a seismograph, which for the present at least will be installed at the Blue Hill Observatory.

The Administration Hall of the Oklahoma State University, erected about four years ago at a cost of $85,000, was totally destroyed by fire on the afternoon of December 20. The flames started from the explosion of a gasoline stove in use on the roof by some workmen engaged in painting the dome. Arrangements are complete for the distribution among the other buildings of the classes affected, so that no recitation will be omitted on account of the fire. The records were saved and the loss on equipment was slight. By hard work the library building, and more especially Science Hall were saved without damage except slightly from water. The hall was insured for $67,000, and rebuilding will begin at once.

The Edward Davies Chemical Laboratories at Aberystwyth University College, the gift of the Llandinam family, have been opened by Mr. Asquith.

A chair for photography is to be established in the Technical Institute at Dresden.

Dr. William H. Welker, assistant in biological chemistry at Columbia University, has been appointed demonstrator of physiological chemistry at the University of Pennsylvania, where he succeeds Dr. P. B. Hawk.